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AUTHOR Lind, Mary; And Others
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ABSTRACT

Designed to supplement the science-mathematics curriculum for students of grades five through nine, this booklet contains activities which focus on the theme of space science. Specific mathematics skills and science processes are identified and indexed for the 20 activities. Topic areas such as the orbits of the planets, movement of the moon, weight on other planets, and space travel time serve to provide opportunities for student investigations and applications of skills. Each activity consists of student sheets and a teacher's guide. The teacher's guide contains information on the activities including: (1) topic area; (2) introductory statement; (3) math and science skills; (4) required materials; (5) key questions; (6) background information; (7) management details; (8) instructional procedures; (9) student procedures; (10) discussion questions; (11) activity extensions; and (12) curriculum coordinates. A fact sheet on the planets is included and additional resources and related software are also identified. (ML)

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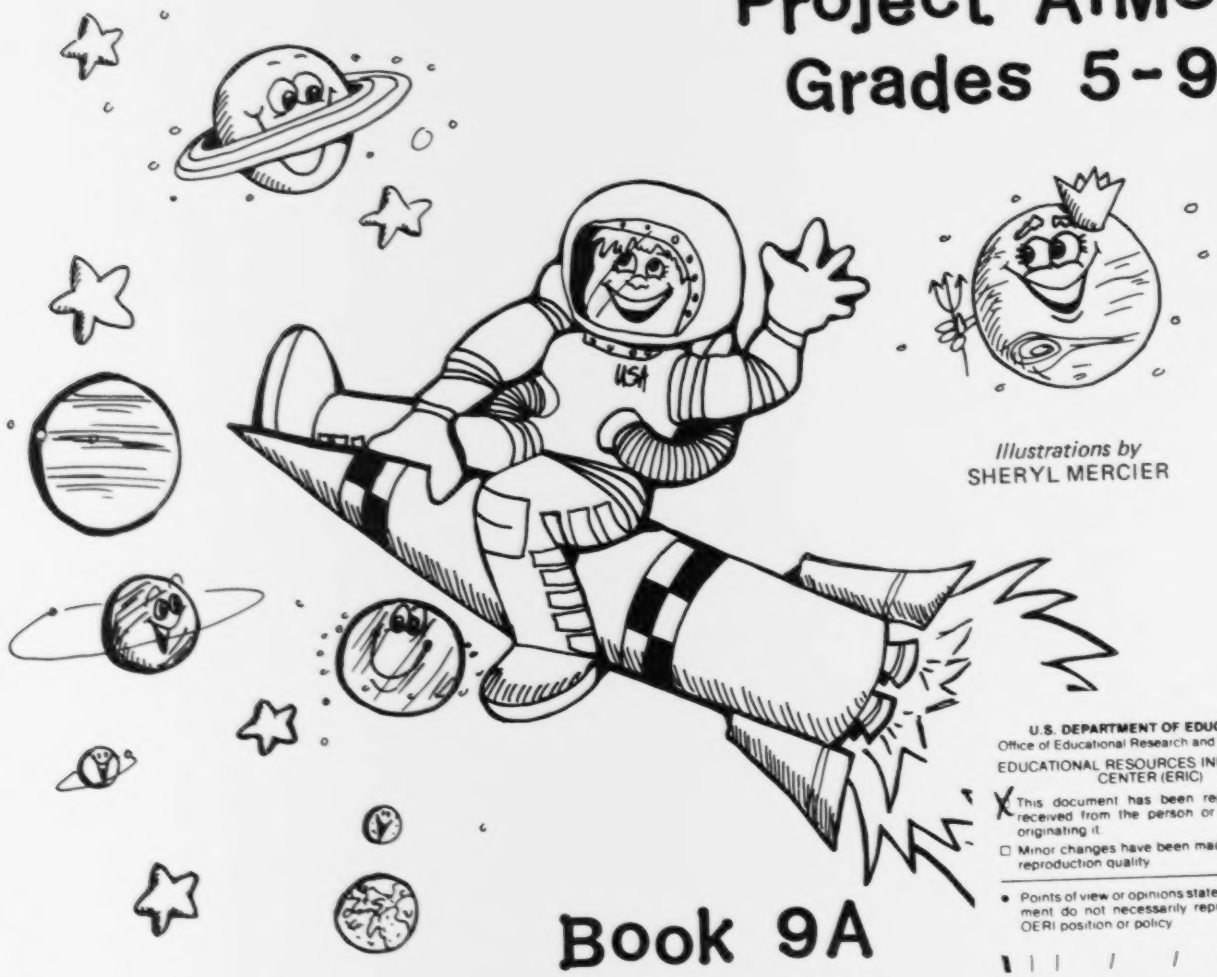
Out of This World

Project AIMS
Grades 5-9



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Out of This World

by

Principal Author
Mary Lind
4-5th Grade Magnet Coordinator
Monterey Peninsula Unified School District
Monterey, CA

Contributing Authors

Ana Williams
5-6th Grade Teacher
Standard School District
Bakersfield, CA

Pam Knecht
4th Grade Teacher
Beardsley School District
Bakersfield, CA

ILLUSTRATIONS

by

Sheryl Mercier

EDITORS

Arthur Wiebe
Program Director
AIMS Education Foundation

Judith A. Hillen
Program Director
AIMS Education Foundation

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Grades 5-9 Series

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Project AIMS

Project AIMS has as its purpose the integration of subject matter in K-9. Such integration enriches and makes learning meaningful and holistic. Project AIMS began as a program to integrate mathematics and science, but has since developed to also include language arts, social studies, and other disciplines. The acronym "AIMS" stands for "activities to integrate mathematics and science."

Project AIMS is a continuing, non-profit project of Fresno Pacific College. It had its inception in a National Science Foundation funded program to train teachers in the integration of mathematics and science. This quickly created the necessity to write instructional materials incorporating this concept. Despite the fact that thoughtful educators have long recommended this approach, very little appropriate material was available.

Currently, Project AIMS is funded solely through the sale of this developing series of books. All net proceeds from their sale flow into a trust fund administered by Fresno Pacific College. The use of this fund is restricted to the support of continued research and development, partial scholarships for classroom teachers who participate in the writing and field testing teams, and the publication of the books.

Two writing teams have completed their work. The first consisted of seventy-five teachers in grades 5-9 who met over a period of eighteen months. The second involved thirty-five K-4 teachers who wrote during a two-year span. In the fall of 1985 a third team of approximately fifty teachers in grades 2-9 will begin writing. In addition, over a hundred teachers have been involved in field testing newly created materials.

The rationale for this integrative thrust lies in the fact that science, mathematics, language arts, social studies, etc., are integrally interwoven in the real world outside the classroom, from which it follows that they should be similarly treated in the classroom if we are to prepare our students for life in that world. Teachers who have used Project AIMS lessons give enthusiastic endorsement to the effectiveness of this approach.

Science encompasses the art of questioning, investigating, hypothesizing, and discovering. Mathematics is the language that provides clarity, objectivity, and understanding. The language arts provide us with powerful tools of communication. Many of the major contemporary issues involve societal issues stemming from advancements in science. It is time, therefore, that all of us in the teaching profession take seriously using a more holistic mode of transmitting knowledge to students. It is this that motivates all of us who are involved in creating or using the integrative materials of Project AIMS. We invite you to join us in this effort.

Extensive field testing of these materials confirms the following beneficial results.

1. Mathematics becomes more meaningful, hence more useful, when it is applied to situations that interest students.

2. The extent to which science is studied and understood is increased, with a significant economy of time resulting from the integration of two or more disciplines.

3. There is improved quality of learning and retention, supporting the thesis that learning which is meaningful and relevant is more effective.

4. Motivation and involvement are increased dramatically as students investigate real world situations and participate actively in the process.

We invite you to become part of this classroom teacher movement by using an integrated approach and by sharing any suggestions you may have or investigations you would recommend. Project AIMS welcomes you!

Project AIMS Publications

GRADES 5-9 SERIES

Math + Science, A Solution
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Fun With Foods
Floaters and Sinkers
Down to Earth
Our Wonderful World
Pieces and Patterns, A Patchwork in Math and Science
Out of This World, Book A

GRADES K-4 SERIES

Fall Into Math and Science
Glide Into Winter With Math and Science
Spring Into Math and Science
Seasoning Math and Science, Book A (Fall and Winter)
Seasoning Math and Science, Book B (Spring and Summer)
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I HEAR, AND I FORGET

I SEE, AND I REMEMBER

I DO, AND I UNDERSTAND

–Chinese Proverb

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The Earth and Her Neighbors

The word planet comes from the Greek word planetai, meaning wanderers. To the ancient peoples, the planets in their orbits seemed to move around the sky. The Greeks and Romans named the planets after mythological gods and goddesses. The symbols used to represent the planets often reflect these names.

MERCURY: Mercury, closest to the sun is a small, dense, fast-moving planet. It circles the sun in a mere 88 days (Earth days). The winged helmet and snake entwined staff of Mercury, the messenger of the Roman Gods, can be seen in the symbol for this planet.

VENUS: The thick acid clouds which surround Venus reflect sunlight and we see it as the lovely morning and evening "star." Venus was named for the Roman goddess of love and beauty and its symbol, a hand mirror is also the universal symbol for women.

EARTH: The planet we know best orbits within the "ecosphere," just the right distance from the sun to provide us with the temperatures and water necessary for our forms of life. The tilt of its axis gives us our seasons. The symbol for Earth is the Greek sign for sphere. Earth is the only planet not named for an ancient god.

MARS: The reddish mineral covering Mars gives it its name, the Red Planet. Because of its color, it was named for the Roman god of war, who was covered with blood. His shield and spear form the planet's symbol which is also the universal sign for man. Mars also tilts on its axis, giving it seasons. Since Mars takes twice as long to circle the sun, its seasons are twice as long as earth's.

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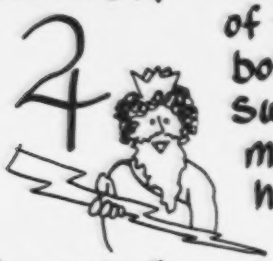
JUPITER

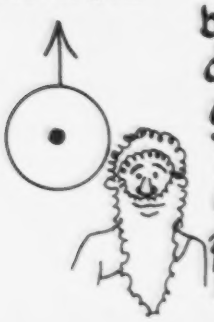


Jupiter, the largest planet, is aptly named for the King of the Roman gods and symbolized by his lightning bolt. Jupiter fascinates us with its 16 known moons, swirling poisonous gases, and Great Red Spot. In this spot, more than three times the size of the Earth, a giant storm has raged for hundreds of years.

SATURN

Early astronomers described Saturn's rings as "ears." This beautiful planet is a huge, floating ball of gas. Voyager's recent fly by shows at least 20 moons. Titan, the largest, is bigger than Mercury and has its own atmosphere. Because of its slow movement, Saturn was named for the Roman god of reaping or time whose symbol is a sickle.

URANUS



Ancient man could not see this seventh planet or any beyond because they did not have telescopes or binoculars. Following its discovery in 1741, astronomers named Uranus for the Roman god who was father to Saturn and grandfather to Jupiter. Its symbol is the sign for the metal platinum. As Uranus orbits the sun, it spins rapidly on its side, its axis always pointing in the same direction. In 1986, Voyager 2 discovered 10 new moons and several more rings around Uranus.

NEPTUNE

A strange pull on the planet Uranus gave astronomers the idea that Neptune existed. Discovered in 1841, the new planet was named for the Roman god of the sea. Its symbol is his fishing spear, the trident. Little is known about the smallest of the gas giants. It has 2 moons and faint rings.

PLUTO

The darkest and farthest of the planets, Pluto, was named for the god of the underworld. It was discovered in 1930, the only planet found in the twentieth century. The Pl of Pluto is its symbol, and is also the initials of Percival Lowell, the first man to predict its existance. Because of its distance from the sun, Pluto's orbit is the most elliptical or oval shaped of the planets and at times is actually closer than Neptune. Pluto's moon, Charon, is nearly as large as Pluto and some scientists consider it a double planet.

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CAN YOU PLANET?

I. Topic Area
Planets

II. Introductory Statement
Students will use a table of facts about the planets to fill in a Venn diagram, answer questions, and graph information.

III. Math Skills
a. Graphing
b. Computation With Whole Numbers
c. Averaging
d. Percent
e. Attributes
f. Problem Solving
g. Set Theory

Science Processes
a. Classifying
b. Comparing Data
c. Interpreting Data
d. Predicting and Inferring
e. Applying and Generalizing
f. Drawing Conclusions

IV. Materials
Student Worksheets
Scissors
Pencils

V. Key Question
Using a Venn diagram, can we group information about the nine planets?

VI. Background Information
Information about the planets varies from book to book. New information is always being obtained. The children need to know that the information on the chart is as up-to-date as possible but may change. If you have not talked about Venn diagrams before, you should do a simple one as a class before attempting this page.

VII. Management
1. This activity will take about 45-60 minutes.
2. Students can work in pairs or small groups.
3. Discussion questions can be done orally or use the work page included.
4. Calculators can be used to do the averaging and percent.
5. After working with the individual Venn diagrams, a large class diagram can be made and displayed.

IX. Procedure
1. Students will read information on the chart.
2. Students will fill in the Planetary Helping Table.
3. Students will cut planets on dotted lines or may use planet symbols, or names.
4. Students will use the information on the Helping Table to place the planets in the appropriate circles or intersections on the Venn diagram.
5. Discuss similarities and differences about the planets based on the Venn diagram.
6. Perform a variety of mathematical problems orally or on the worksheet, using the information from the diagram and chart.
7. Use the information from the diagram to fill in the graphs, how many moons, and what's my size. Use different colors for each bar on the graphs.

X. Discussion
The Diagram:
1. Which planets are larger than the earth?
2. Which planets have moons?
3. Which planets have days longer than 24 hours?
4. Which planet fits all three categories?
5. Which planets have no moons?
6. Which planets are smaller than the earth?
7. What percent of the planets have moons?
8. What percent of the planets are smaller than the earth?

The Chart
1. Which planet has the most moons?
2. What is the total number of moons?
3. What is the average number of moons?
4. Which two planets are the closest in size?

XI. Extensions
1. Using the cutouts, arrange the planets in order from smallest to largest, longest day to shortest day, number of moons, etc.
2. Have students do research reports on individual planets.

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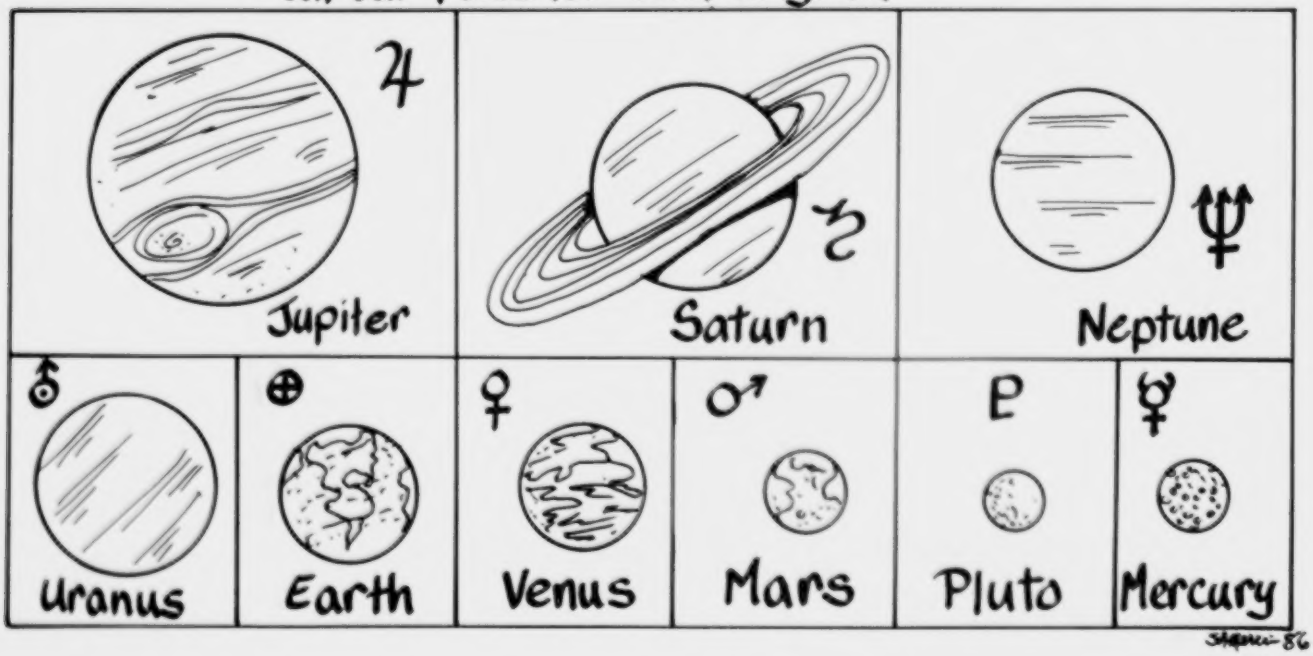
Name: _____

CAN YOU PLANET?

PLANETARY FACTS

	Diameter	Moons	Length of Day
Mercury	4,880 Km	0	59 days
Venus	12,104 Km	0	243 days
Earth	12,756 Km	1	23 hours 56 minutes
Mars	6,787 Km	2	24 hours 37 minutes
Jupiter	142,800 Km	16	9 hours 55 minutes
Saturn	120,600 Km	20	10 hours 14 minutes
Uranus	50,800 Km	15	24 hours
Neptune	48,600 Km	2	22 hours
Pluto	3,000 Km	1	6 days 9 hours

Cut out & use for Venn Diagram



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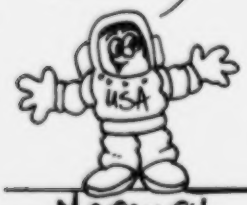
Name _____

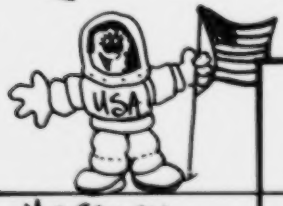
CAN YOU PLACE?

Sort out the planets. Next to each planet's name, color in those spaces that are true. Use this information to place the planets on the Venn Diagram.



Planetary Facts Helping Table

	Larger than Earth	Day 24 hours or More	Has Moon(s)
Mercury			
Venus			
Earth			
Mars			
Jupiter			
Saturn			
Uranus			
Neptune			
Pluto			



More Planetary Facts (Venn Again)

Mercury			
Venus			
Earth			
Mars			
Jupiter			
Saturn			
Uranus			
Neptune			
Pluto			

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Name: _____

CAN YOU PLANET?

Cut apart the planets from the previous page. Use the information from the chart to place the planets in the correct circle or junction of circles.

Larger than Earth

Has Moon(s)

Length of Day 24 hrs. or longer

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Name: _____

CAN YOU PLANET?

Use the Venn Diagram or chart to answer the following questions.

1. Which planets are larger than Earth? _____

_____

2. Which two planets are closest in size? _____ _____

3. What percent of the planets are smaller than Earth? _____

4. Which planets have moons? _____

_____

5. Which planet has the most moons? _____

6. What is the total number of known moons in our solar system? _____

7. What is the average number of moons per planet? _____

8. Which planet fits into all three categories? _____

9. Which planets have days which are longer than 24 hours?

_____

Think of two more questions you can ask your classmates. Write them below.

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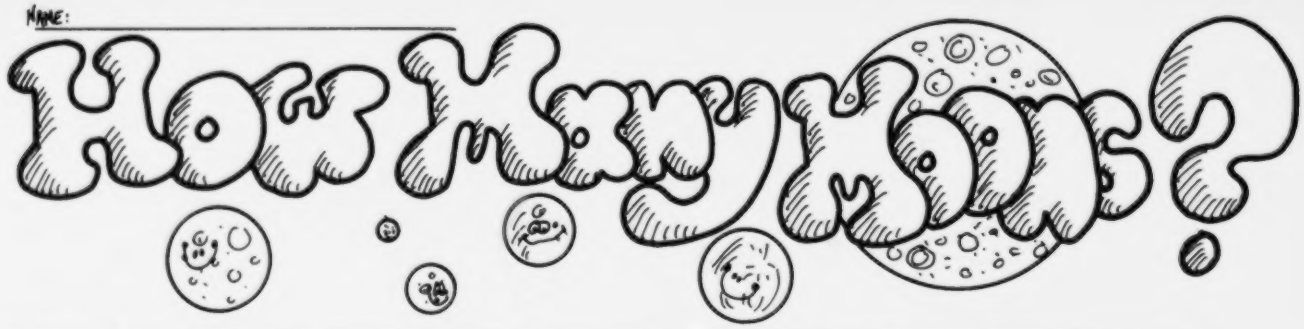
NAME: _____

How Many Moons?



30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Mercury ☿	Venus ♀	Earth ⊕	Mars ♂	Jupiter ♃	Saturn ♄	Uranus ♅	Neptune ♆	Pluto ♇

OUT OF THIS WORLD

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What's My Size?

Name _____

GRAPH THE DIAMETERS OF THE PLANETS.
EACH SPACE IS EQUAL TO 5,000 KILOMETERS.

	0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160
Mercury	
Venus	
Earth	
Mars	
Jupiter	
Saturn	
Uranus	
Neptune	
Pluto	

OUT OF THIS WORLD

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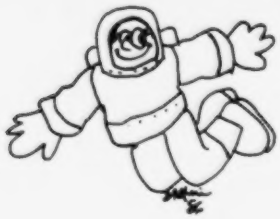
PLANETARY FACTS



(Venn Again)

I. Topic Area
Planets

II. Introductory Statement
Students will choose three areas of knowledge about the nine planets and generate a Venn diagram from that information. Students will create graphs to show what they have learned.

III. Math Skills
a. Graphing
b. Computation
c. Attributes
d. Set Theory
e. Problem Solving

Science Processes
a. Classifying
b. Comparing Data
c. Interpreting Data
d. Predicting and Inferring
e. Applying and Generalizing
f. Drawing Conclusions

IV. Materials
Student Worksheets
Research materials or tables of information
Graph Paper

V. Key Question
What are some other types of information about the planets we can use to make Venn diagrams?

VI. Background Information
Other areas include distance from the sun, length of year, density, mass, surface gravity, and distance from the earth. Students could research these topics and create a table like the one used in the previous activity or the teacher could provide additional tables of information (included at the end of this page).

VII. Management
A. Time for this activity will vary depending on whether students are using tables or need to gather their data.
B. Students can easily work in small groups to gather data, generate the Venn diagram, and create the graphs.

VIII. Procedure
A. Students will choose three topic areas to form ulate a Venn diagram.
B. Students will group the nine planets according to the topics chosen.
C. Students will generate discussion questions for classmates regarding their Venn diagram.
D. Students will create a large class Venn diagram to describe their set of information.
E. Students will graph the information.
F. Students will formulate mathematical questions using information from the three topic areas they have chosen.
G. Planetary Helping Table from "Can You Planet?" may be used as a preliminary step to creating the Venn diagram.

X. Discussion
A. Which areas did you choose to display in the Venn diagram?
B. Were there some areas that were easier to use in a Venn diagram than others?
C. What kind of questions can you ask about each of the topic areas?
D. Were you able to create graphs for all topic areas?

XI. Extensions
Make Venn diagrams covering other topic areas beside the planets.

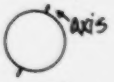
PLANETARY FACTS TERMS

Information about our solar system is constantly changing. New information is being obtained through photographs and other data sent back by Voyager 2. Plans for a space telescope will increase our knowledge even more.

DIAMETER: This is the length of a line passed through the middle of a sphere. The larger the diameter, the larger the planet or sphere.

MOONS: This is the number of natural satellites a planet has. Some planets have no moons and some probably have moons we have yet to discover.

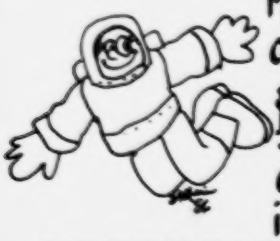
LENGTH OF DAY: This is determined by how long it takes the planet to rotate once on its axis. Time for all the planets is based on earth time.



LENGTH OF YEAR: This is the amount of time it takes a planet to make one complete orbit around the sun.

DISTANCE FROM THE SUN AND EARTH: These are measured in millions of kilometers. The distances given are the average distance a planet is orbiting from the sun or the earth most of the time. As the orbits of the planet are eliptical rather than circular, a planet will sometimes be closer and sometimes farther in the course of the year.

MASS: This is the amount of material that something contains. Mass and weight are not the same thing. An object aquires weight due to the pull of gravity such as a planet's. A person or object is weightless in space but still has mass. For comparison, the mass of the earth is considered as 1 and other planet's masses are in relation to that.



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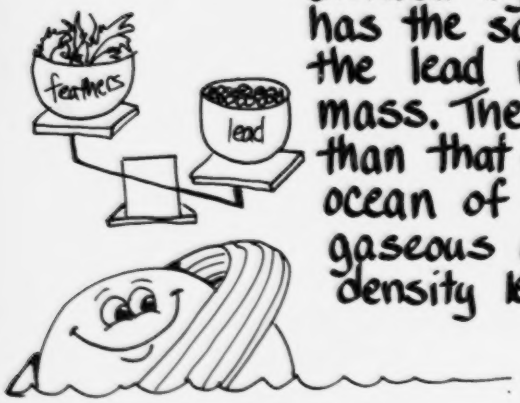
PLANETARY FACTS

TERMS

DENSITY Density tells how tightly mass is packed and is determined by the mass of an object divided by its volume. A basket of feathers has the same volume as a basket of lead but the lead is denser, and so would have a greater mass. The inner planets have a density greater than that of water and would sink in a giant ocean of water. The outer planets are more gaseous and so less dense. Saturn has a density less than water and would float.



SURFACE GRAVITY Gravity is the force that pulls or holds an object to a planet. The more mass a planet has, the greater pull and the more you would weigh there. Yet, you would weigh just over two and one half times greater on Jupiter, not 3/8 times because gravitational pull lessens with distance. Jupiter's gaseous surface is far from its massive center.

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PLANETARY FACTS

Name _____

	Distance from Earth in Millions of Km	Density	Surface Gravity	Distance from Sun in Millions of Km	Mass	Length of year
Mercury	85	5.4	.39	58	.055	88 days
Venus	40	5.3	.91	108	.815	225 days
Earth	0	5.5	1	150	1	365 days
Mars	56	3.9	.38	228	.107	687 days
Jupiter	628	1.3	2.60	778	317.9	11.86 years
Saturn	1,276	.7	1.07	1,427	95.2	29.46 years
Uranus	2,736	1.2	.90	2,870	14.6	84 years
Neptune	4,310	1.7	1.15	4,497	17.2	165 years
Pluto	4,345	.3-.8	.05	5,900	.002	248 years

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PLANETARY FACTS

Name _____

	Distance from Earth in Millions of Km	Density	Surface Gravity	Distance from Sun in Millions of Km	Mass	Length of year
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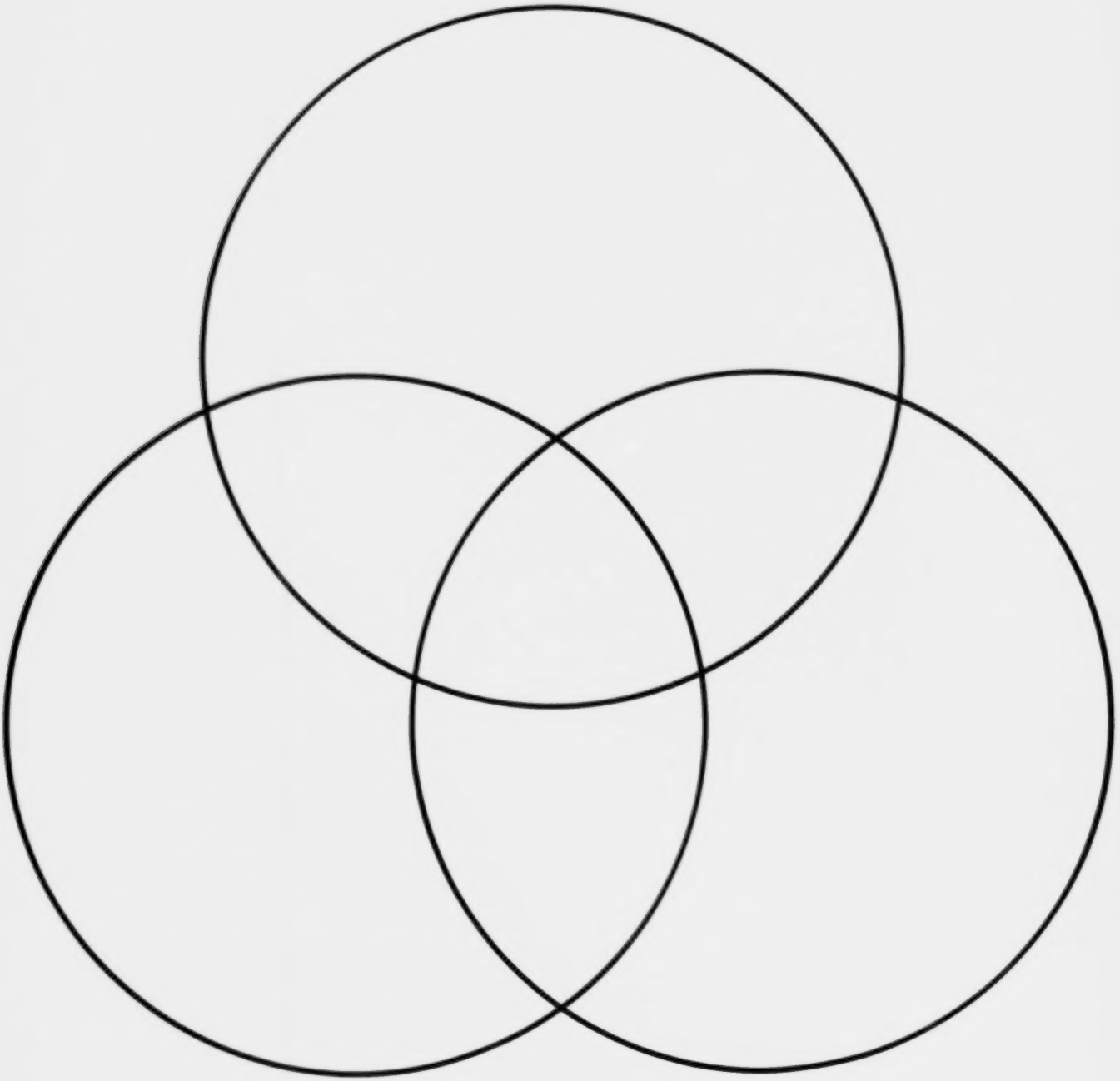
PLANETARY FACTS



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Spacing Out the System

I. Topic Area
Planets

II. Introductory Statement
Students will determine the relative distance of the planets in order to construct a model solar system.

III. Math Skills
a. Computation
b. Rounding
c. Estimation
d. Problem Solving
e. Reading and Interpreting Tables
f. Decimals
g. Measuring Length

Science Processes
a. Recording Data
b. Interpreting Data
c. Inferring
d. Making and Testing Hypotheses
e. Applying and Generalizing

IV. Materials
Two Student Worksheets
Pencils
Calculators (optional)
Metric Rules and Tapes
Trundle Wheel

V. Key Question
Can we make a model solar system in the class or on the playground with the relative distances of the planets?

VI. Background Information
Information about what an astronomical unit is is provided on the student information page. Astronomers use astronomical units to measure distances that are too small to be measured in light years. The distance of each planet from the sun is provided in the chart for the activity "Can You Planet?" Students can refer to that chart or the teacher can provide it. To find the astronomical unit students use a comparative ratio. By simply dividing the distances in millions of kilometers students can work with smaller numbers. After they have determined relative distances they can let the earth equal any distance they wish and simply multiply that by the relative distance to create their model. Distances given are the average mean distance a planet is from the earth or the sun. Using the distance of earth from the sun as one centimeter students can space the planets on a piece of 12×18 paper. Using .5 meter to represent earth students can measure out relative distances on most school playgrounds. The following chart shows relative distances and sizes to scale.

Planet	Model Scale	Distance Scale
Mercury	1 mm	12 m
Venus	2 mm	22 m
Earth	2 mm	30 m
Mars	1 mm	46 m
Jupiter	28 mm	155 m
Saturn	26 mm	285 m
Uranus	10 mm	574 m
Neptune	9 mm	899 m
Pluto	1 mm	1,191 m

VII. Management
A. This activity probably will take two class periods; one period to complete the computation and another to actually measure the distances.
B. Students can work in pairs or small groups to do this activity.
C. Students need to have some idea of how a ratio works before completing the activity.
D. In worksheet one, let the distance for earth equal one centimeter. Students can cut circles to represent the planets or use the following seeds and nuts. Radish seeds: Mercury and Pluto, split pea: Mars, dried pea: Earth and Venus, lima beans: Uranus and Neptune, and walnuts: Jupiter and Saturn. This scale will fit on a 12×18 paper.
E. Relative size can be determined using the worksheet in the following lesson, "Size It Up."
F. In worksheet two, let a building or wall represent the location of the sun. The distance of the earth may be any amount you decide and depends on the size of your playground. One way to determine this is to have students use metric tapes or a trundle wheel to measure the farthest distance on the playground. From that they can decide what value they can give to Earth so all the planets will fit.

IX. Procedures
A. Students fill in the distances from the sun for each planet.
B. Students divide distances by 150.
C. Students may use calculators or not. Answers should be rounded to the nearest tenth.
D. Using those answers as relative distances students make a model solar system in the classroom by measuring one centimeter from the end of a 12×18 piece of paper and use circles or seeds to represent the planets.
E. Have students use their predetermined measurements to construct a model solar system on the playground.

X. Discussion
A. What do you notice about the distances from the sun of the inner planets and the outer planets?
B. What observations did you make while looking at the playground model?

XI. Extensions
If space permits either in the classroom or outside, choose a central location for the sun and place the planets the relative distance away. This is more realistic since the planets are not lined up in a straight line but rather in different places in their orbits.

[1]From J. Abruscato et al. **Holt Science** [Grade 5 Pupil Book] (New York: Holt, Rinehart and Winston, 1986). p. 323.

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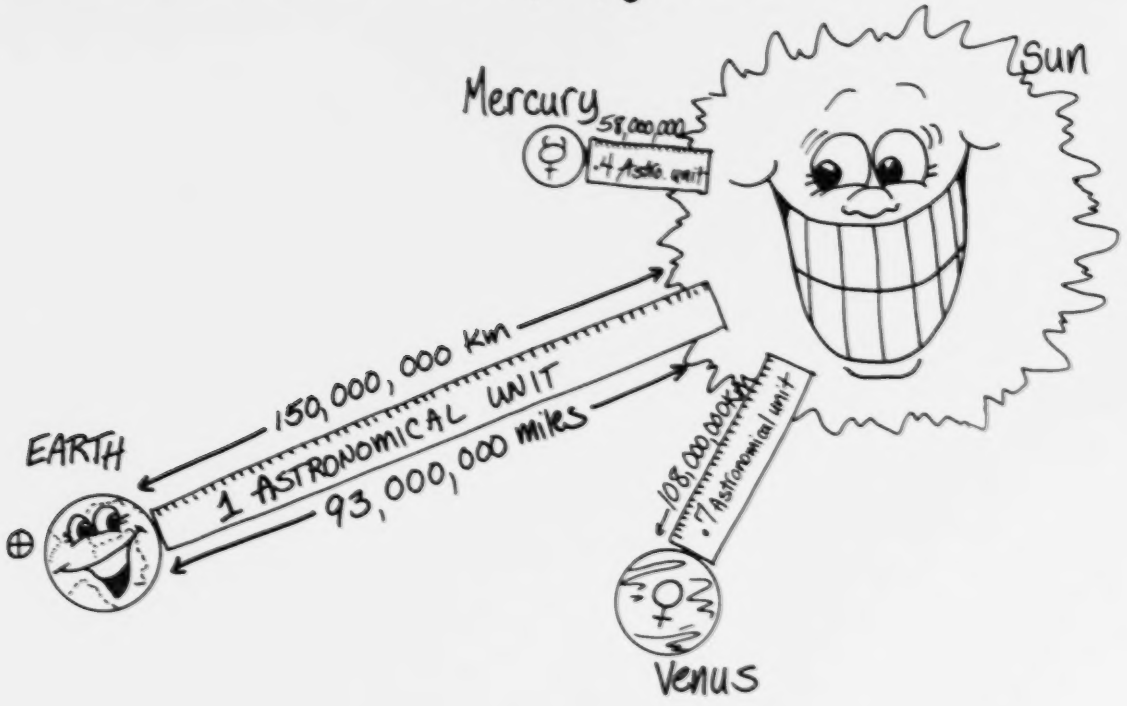
Spacing Out the System

Astronomical Unit

Astronomers have chosen a unit to measure space distances called the astronomical unit. The length of an astronomical unit is the average distance of the earth from the sun. The distance is rounded to 93,000,000 miles or 150,000,000 kilometers. The exact figure is not as important as the ratio or relative distance of the planets from the sun. Using astronomical units, those relative distances stay the same whether we use miles, meters, or centimeters.

Using 150,000,000 kilometers as one astronomical unit, you can create a model solar system in your classroom or on the playground.



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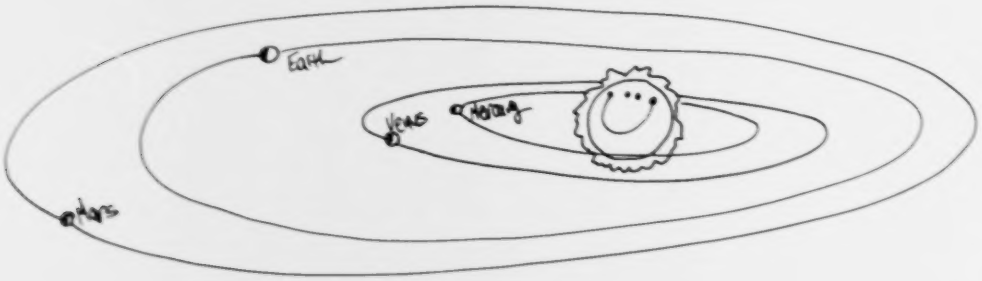
Spacing Out the System

Orbital Distance



The planets travel in eliptical rather than true circular orbits as they make their way around the sun. This means that they are sometimes closer and sometimes farther away. The distances we are using are called the "mean average." This means the average between a planet's farthest point from the sun or earth and its nearest point. The maximum, minimum, and mean average distances for Earth, Uranus, Neptune, and Pluto are listed below.

	Earth	Uranus	Neptune	Pluto
Maximum distance from Sun in millions of kilometers	152.1	3,004	4,537	7,375
Minimum distance from Sun in millions of kilometers	147.1	2,735	4,456	4,425
Mean distance from Sun in millions of kilometers	150	2,870	4,497	5,900

Pluto has a particularly elongated orbit and at its minimum distance is actually closer to the sun than Neptune.

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astronomer

Spacing Out the System

In order to create a model of the solar system that is accurate in terms of distance you use the astronomical unit, which is the average distance of the earth from the sun, or 150,000,000 kilometers. The distance of the earth from the sun is then equal to one unit. By creating a ratio for each of the other planets, you can determine their relative distances. Here is an example using the planet Mercury.

Distance from the sun in millions of Kilometers — Relative Distance

MERCURY $\frac{58}{150} = \frac{N}{1}$

EARTH

Cross multiply and you find that 150N equals 58. Divide both sides by 150 and you have the relative distance of Mercury from the sun.

Complete the chart below. Round your final answer to the nearest tenth.

PLANET	Distance in millions of Kilometers ÷ 150 = Relative Distance	Rounded to Nearest Tenth
MERCURY	÷ 150 =	
VENUS	÷ 150 =	
EARTH	÷ 150 =	
MARS	÷ 150 =	
JUPITER	÷ 150 =	
SATURN	÷ 150 =	
URANUS	÷ 150 =	
NEPTUNE	÷ 150 =	
PLUTO	÷ 150 =	

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Astronomer

(page 2)

Spacing Out the System

Use the relative distances from the previous page to complete the table below for creating a model solar system for the classroom and playground. Use this information to construct one or both models. Start at one end of a bulletin board or playground and label the sun. Use the chart below and measure to show the relative distances. In the classroom you can also use objects or circles of relative size. On the playground, have a person hold a sign for each planet and stand the measured distance apart. Take turns observing from a distance.

Classroom : Let Earth equal 1 centimeter

Playground : Let Earth equal .5 meter

PLANET	CLASSROOM	PLAYGROUND
MERCURY ☿		
VENUS ♀		
EARTH ⊕		
MARS ♂		
JUPITER ♃		
SATURN ♄		
URANUS ♅		
NEPTUNE ♆		
PLUTO ♇		

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Topic Area

I. Planets

Introductory Statement

II. Students will determine the relative sizes of the planets in order to construct a model solar system.

Math Skills

III. a. Computation
b. Rounding
c. Estimation
d. Problem solving
e. Reading and interpreting tables
f. Decimals
g. Geometry-constructing circles, measuring diameters

Science Processes

a. Recording data
b. Interpreting data
c. Predicting and inferring
d. Making and testing hypotheses
e. Applying and generalizing

Materials

IV. Student worksheets
Calculators (optional)
Metric rulers and tapes
Construction paper
Pencils
Clay
Compasses

Key Question

V. Can we make a model solar system that will show the relative sizes of the planets?

Background Information

VI. To make a scale model of the solar system students must give the diameter of the earth a value such as 1 centimeter and use comparative ratios to determine the relative sizes of the rest of the planets. The diameters of each planet are provided in the chart for the activity "Can You Planet?" Students can refer to that chart or the teacher can provide the information. Directions for setting up the ratio are on the student page. After they have determined relative sizes they are to construct clay balls of relative sizes to use in their model solar system. In worksheet 2 students are given diameter lines on which to form these balls. Students may then construct larger circles from construction paper using a larger number, such as 10, for the earth's diameter.

Management

VII. a. This activity may take two class periods; one period to complete the computations and another to actually construct the circles.
b. Students can work in pairs or small groups to do this activity.
c. Students need to have some idea of how a ratio works before completing the activity.
d. You can use any number to equal the diameter of earth. One was selected to facilitate the formation of the clay balls.
e. Larger circles can be constructed from paper by determining the radius and using compasses.
f. Students need to divide the diameter by 2 to find the radius of each planet for use in constructing the paper models.

Procedures

VIII. a. Students fill in the diameters for each planet.
b. Students divide diameters by 12,756, the earth's diameter.
c. Students may use calculators or not. Answers should be rounded to the nearest tenth.
d. Using those answers as relative diameters students make a model solar system in the classroom by constructing clay spheres and/or construction paper circles and placing them relative distances apart.

IX. **Discussion**

a. What do you notice about the sizes of the various planets?
b. Why was the radius used to construct the paper planets?

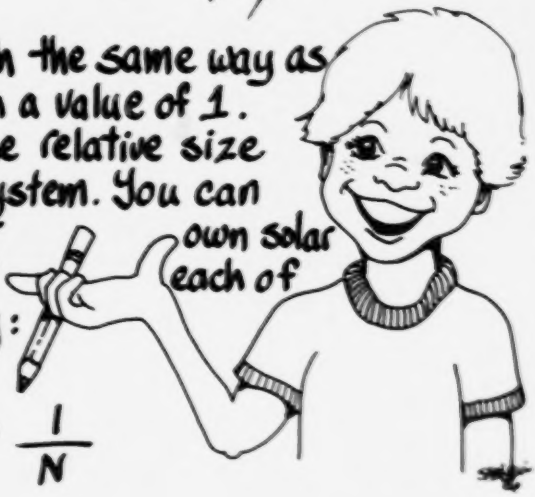
X. **Extensions**

Once students have constructed the circles they can experiment to see how many earth's it would take to cover Jupiter etc.

Size it Up

Relative Size

Relative size can be determined in much the same way as relative distance. Give the diameter of earth a value of 1. By creating a ratio, you can obtain the relative size diameter for each planet in the solar system. You can then use that relative size to make your own solar system model by setting up a ratio for each of the planets. Here is a sample using Mercury:



$$\frac{\text{MERCURY'S DIAMETER}}{\text{EARTH'S DIAMETER}} : \frac{4880}{12{,}756} = \frac{1}{N}$$

Cross multiply and you get the equation $4880 = 12{,}756N$. By dividing both sides by 12,756 you obtain the relative diameter for Mercury. Complete the chart below for all the planets.

Planet	Diameter	÷ (EARTH'S DIAMETER)	= Relative Diameter
Mercury		÷ 12,756	=
Venus		÷ 12,756	=
Earth	12,756	÷ 12,756	= 1
Mars		÷ 12,756	=
Jupiter		÷ 12,756	=
Saturn		÷ 12,756	=
Uranus		÷ 12,756	=
Neptune		÷ 12,756	=
Pluto		÷ 12,756	=

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Size it Up

Solar System Scale Models

Mercury

Venus

Earth

Mars

1. Make a scale model of the solar system out of clay. The relative diameter for each planet is drawn on the page for you. Form balls of clay with diameters to match. Put the planets in order on your desk.

Jupiter

Saturn

Uranus

2. Make a larger model of the solar system from paper. Do the computations then use a compass to construct the circles. Color and post.

Neptune

Pluto

Planet	Relative Diameter	Scale Diameter (x 10)	Radius (÷2)
Mercury	.38		
Venus	.95		
Earth	1	10cm	5cm
Mars	.53		
Jupiter	11.19		
Saturn	9.45		
Uranus	3.98		
Neptune	3.81		
Pluto	.24		

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Planetary Scavenger Hunt

I. Topic Area

Planets

II. Introductory Statement

Students will use a marble to represent the size of the earth and try to find other spherical objects of relative sizes to represent the rest of the planets.

III. Math Skills

a. Computation
b. Rounding
c. Estimation
d. Measuring diameters
e. Problem solving
f. Reading and interpreting tables
g. Decimals

Science Processes

a. Recording data
b. Interpreting data
c. Predicting and inferring
d. Making and testing hypotheses
e. Applying and generalizing

IV. Materials

Student worksheets
Pencils
Calculators (optional)
Metric rulers and tapes
Books
Balls and other spherical objects

V. Key Question

Can we locate everyday spherical objects to represent the relative sizes of the earth and the planets?

VI. Background Information

To make a scale model of the solar system using spherical objects students must first have an object to represent earth such as a marble. They then measure the object to determine the constant factor. By multiplying the relative diameters of the other planets by this constant they determine the diameters their other objects must have. They then locate objects to represent the other planets. Objects to provide could include seeds of various sizes, a variety of marbles, rubber balls, tennis balls, and larger playground balls.

VII. Management

a. This activity may be done over an extended period of time as students search for objects. Several objects could be provided in a classroom setting or students could do this as an out of class project and share objects they have found.
b. Students should work in pairs or small groups to do this activity.
c. You can use any object to equal the diameter of earth. A marble was selected because both larger and smaller spheres would be relatively easy to locate.
d. Students determine the diameter of a marble by placing it between two rulers and measuring the distance across as shown. One student holds two rulers upright against the object while the other student measures the distance between the rulers.
e. Students need to be reminded that all measured numbers are approximate and that they may not find spheres that are exactly equal to a planet's diameter.

VIII. Procedures

a. Students measure the diameter of the marble to represent Earth. (This number is then recorded in both the needed and actual columns for Earth.)
b. Students multiply each planet's relative diameter by the diameter of the marble to determine the needed diameter and record those numbers on the chart.
c. Students measure other spherical objects such as balls, seeds, fruit, etc. to find objects with approximate diameters equal to those of the other planets.
d. Record the names of those objects and their diameters and subtract to find the differences.

IX. Discussion

a. What do you notice about the sizes of the various planets?
b. Did everyone choose the same object to represent a particular planet?
c. Were some planets harder to find?

X. Extensions

Students could start with a large object like a beach ball representing Jupiter and locate other objects relative to that.

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Planetary Scavenger Hunt

Use a marble to represent earth. Measure its diameter and record. That measurement is the constant factor. Multiply each planet's relative diameter by the constant to determine the needed diameter. Scavenge for spheres with appropriate diameters to represent the planets. Measure, record, and find the difference.

	Diameter in Km	Relative Diameter
Mercury	4,880	.38
Venus	12,104	.95
Earth	12,756	1
Mars	6,787	.53
Jupiter	142,800	11.19
Saturn	120,600	9.45
Uranus	50,800	3.98
Neptune	48,600	3.81
Pluto	3,000	.24

Objects:

_____

_____

marble

_____

_____

_____

_____

_____

_____

_____

Needed Diameter	Actual Diameter	Difference

Score:

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EXTRA TERRESTRIAL EXCURSIONS

I. Topic Area
Planets

II. Introductory Statement
Students will compute travel time to the moon and the planets and determine their age on arrival.

III. Math Skills
a. Computation
b. Rounding
c. Estimation
d. Problem Solving
e. Reading and Interpreting Tables
f. Decimals
g. Calculators

Science Processes
a. Recording Data
b. Interpreting Data
c. Predicting and Inferring
d. Making and Testing Hypotheses
e. Applying and Generalizing

IV. Materials
Student Worksheets
Pencils
Calculators (optional)

V. Key Question
Traveling at a speed of 40,000 km per hour, how old do you think you would be on arrival on the moon and each planet?

VI. Background Information
The distance to the moon and each planet in kilometers is listed on the student worksheet. (If a teacher prefers these distances can be researched by the students. The speed of 40,000 kilometers per hour was determined by the speed of space travel we would be capable of today. Obviously there would be more to interplanetary travel than how long it would take and students may bring all those problems up.

Since the anwers to the first three computations should be rounded, rounding strategies should be taught prior to this activity. The last computation (converting months to years) should be done without a calculator, as the remainder will tell them the number of months. This is a good example of a time when computing with a calculator won't work. Worksheet 3 gives students the opportunity to use the information in a problem solving format.

VII. Management
A. Time for this activity will vary depending on the students' math ability and whether or not calculators are used.
B. Students could work in pairs or groups to compute travel time and then individually to compute their age on arrival.
C. The formulas should be discussed before students do the worksheet. The formula rate × time = distance is an important one which students can use in a variety of situations. We use it as a division formula solving for time.
D. Teaching the process of crossing through an equal number of zeroes before dividing is very helpful. If students are dividing without calculators this means they only need to divide by 4.
E. When doing "special delivery," students have to be reminded that a visit to any planet is not complete until return to earth.

VIII. Procedure
A. Students will record their age in years and months.
B. Students will then predict how long it will take to travel to the moon and each of the planets and record their predicted age on arrival.
C. Students will use the formulas to compute travel time to the moon and each planet.
1. Compute hours of travel time by dividing the distance from earth by the speed of 40,000 kilometers per hour. Round to the nearest hour.
2. Compute the days traveled by dividing the hours by 24 and round to the nearest day.
3. Compute travel time in months by dividing days by 30 and rounding to the nearest month.
4. Compute years taveled time by dividing months by 12. This time the remainder is used and the students record the number of years and months.
D. By adding that amount of time to their age they will arrive at their actual age at time of arrival.
E. Students record their actual arrival age in the last column on the worksheet.
F. Students use the information about travel time to answer the questions on special delivery worksheet.
G. Students create their own mystery trips for their classmates to answer.

X. Discussion
A. How did your predictions compare to the actual age you would be?
B. Were you surprised by how long or short a time it would take for interplanetary travel?

XI. Extensions
A. Students could compute how long it would take them to travel to a given planet and return.
B. Students could compute arrival age for another family member such as a parent or younger sibling.
C. Students could list supplies needed for a lengthy voyage.
D. Students could write an imaginary journal of their voyage.

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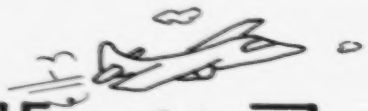
Travel Time

The great distances in space are sometimes difficult to comprehend. If we look first at the time it would take to travel to the moon and the planets by walking, by car, or by jet plane, you can begin to understand what a great undertaking interplanetary travel would be.



TIME IN YEARS FROM EARTH

Planetary Body	Walking 2.5/mph 3.6/Kmph	Car 55 mph 80 Kmph	Jet 990 mph 1436 Kmph
Moon	11	.6	.03
Mercury	2588	133	7
Venus	1175	61	3
Mars	2222	113	6
Jupiter	17,843	909	46
Saturn	36,421	1848	92
Uranus	76,894	3935	194
Neptune	123,579	6289	313
Pluto	162,622	8378	410

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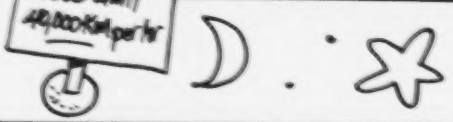
EXTRA TERRESTRIAL EXCURSIONS

SPACE VOYAGER

Name: _____

Age Today

YEARS: _____ MONTHS: _____



AVERAGE DISTANCE FROM EARTH		HOURS	DAYS	MONTHS	YEARS		ARRIVAL AGE	
		Distance / 40,000 (to nearest hour)	Hours / 24 (to nearest day)	Days / 30 (to nearest month)	Month / 12		Years + your Age	
					Years	Months	Years	Months
384,000 Km	Moon							
86,000,000 Km	Mercury							
42,000,000 Km	Venus							
67,000,000 Km	Mars							
628,000,000 Km	Jupiter							
1,227,000,000 Km	Saturn							
2,720,000,000 Km	Uranus							
4,320,000,000	Neptune							
5,557,000,000	Pluto							

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EXTRA TERRESTRIAL EXCURSIONS

SPECIAL DELIVERY

Imagine that you work for the Solar Systems Delivery Service. You need to determine the time necessary to make certain deliveries and return to Earth. The planets are not lined up in a straight line in their orbits around the sun. You must always return to Earth for refueling between planets.

1. Deliver communication systems to Mercury and Jupiter.

   TRAVEL TIME: _____

2. Deliver pizza to Venus and Mars.

   TRAVEL TIME: _____

3. You travel to one outer and one inner planet and back home again. Your journey takes you about 7 years, 6 months. To which planets did you travel?

   Planets: _____ _____

4. Starting at Neptune, you travel home to Earth and then deliver letters to Mars.

   TRAVEL TIME: _____

5. Design a "Mystery" trip to two of the planets. Remember to always stop at the Earth between planets. How long would your mystery trip take?

   TRAVEL TIME: _____

Exchange "Mystery" trips with another student and solve.

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How Long Does it Take to Say.... HELLO?

I. Topic Area

Planets

II. Introductory Statement

Students will compute the time it would take for a message to reach the moon and the planets.

III. Math Skills

a. Computation
b. Rounding
c. Estimation
d. Problem solving
e. Reading and interpreting tables
f. Applying formulas
g. Calculations

Science Processes

a. Recording data
b. Interpreting data
c. Predicting and inferring
d. Making and testing hypotheses
e. Applying and generalizing

IV. Materials

Student worksheets
Pencils
Calculators (optional)

V. Key Question

How long would it take for someone on the moon or one of the planets to hear you say hello?

VI. Background Information

The distance to the moon and each planet in kilometers is listed on the student worksheet. (If a teacher prefers these distances can be researched by the students prior to doing the worksheet.) Radio waves travel at the speed of light so that is the rate used for transmission. The actual speed of light is 299,739 kilometers per second. It is rounded to 300,000 for ease in calculation since the answers should be rounded. Rounding strategies should be taught prior to this activity. Numbers may be rounded to the nearest tenth or whole number. The last computation, (converting minutes to hours), should be done without a calculator, as the remainder will tell them the number of minutes. This is a good example of a time when computing with a calculator won't work.

VII. Management

a. Time for this activity will vary depending on the students' math ability and whether or not calculators are used.
b. Students could work in pairs or groups to compute.
c. The formula should be discussed before students do the worksheet. The formula, Rate x Time = Distance, is an important one which students can use in a variety of situations. We used it as a division formula solving for time.
d. Teaching the process of crossing through an equal number of zeroes before dividing makes the process much easier as students then need only to divide by 3. Students are actually first dividing both numbers by 100,000.

VIII. Procedure

a. Students will use the formula on the worksheet to compute the time for a radio message to reach the moon and each planet.
   1. Compute the number of seconds by dividing the distance from earth by the speed of light. Round to the nearest whole number.
   2. Compute the number of minutes by dividing the seconds by 60, then round to the nearest whole number.
   3. Compute time in hours and minutes by dividing minutes by 60. This time the remainder is used to determine the minutes.

IX. Discussion

What do you notice about the differences in amount of time it takes to communicate with the inner and outer planets? What does that tell you about the distances to those planets?

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SPACE COMMUNICATOR

How Long Does it Take to Say.... HELLO?

Although travel to the far reaches of space is a thing of the future, space communication is not. Exploratory Space Probes, such as Voyager 2, send and receive messages from the very edges of our solar system. Radio waves travel at the speed of light, 299,739 kilometers per second. Use the formulas below to compute how long it would take for your "Hello" to reach the moon and each of the planets.

Destination of Message	Average Distance from Earth in Km	Seconds (Distance / rate) (÷300,000)	Minutes (seconds / 60) (÷60)	Hours (minute / 60) (÷60)
Moon	384,000			
Mercury	86,000,000			
Venus	42,000,000			
Mars	67,000,000			
Jupiter	628,000,000			
Saturn	1,277,000,000			
Uranus	2,720,000,000			
Neptune	4,320,000,000			
Pluto	5,557,000,000			

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SPACE MESSAGE TALK

I. Topic Area
Planets

II. Introductory Statement
Students will compute the time it would take for a series of messages to go back and forth between the moon and the planets.

III. Math Skills
a. Computation
b. Rounding
c. Estimation
d. Problem solving
e. Reading and interpreting tables
f. Time

Science Processes
a. Recording data
b. Interpreting data
c. Predicting and inferring
d. Making and testing hypotheses
e. Applying and generalizing

IV. Materials
Student worksheets
Pencils
Calculators (optional)

V. Key Question
How long would it take to send a series of communications to the moon or one of the planets?

VI. Background Information
Students will have computed the time for a one way transmission in the activity "How Long Does it Take to Say Hello?" Now they will use that to compute the time necessary to complete a series of two way communications. You may use the six sentence script, or have students create their own scripts of any length. It works best if students multiply the time for a one way transmission in minutes (seconds for the moon) and then divide any answers over 60 minutes by 60 to compute at what time and day they will complete their script.

VII. Management
1. Time for this activity will vary depending on the students' math ability and whether or not calculators are used. It will also depend on whether students write their own transmission scripts, and take the time to actually try them.
2. Students compute by adding the time of the total transmission to the day and time they began.
3. Students can work in pairs or cooperative groups.
4. Students need to have their answers in minutes for a one way transmission from the worksheet "How Long Does It Take To Say Hello?"
5. Students then compute the answer to the question, "If you began transmitting at 8:00 a.m., Tuesday, what day and time would you finish?"

VIII. Procedure
1. Students will use the six sentence transmission script or write one of their own.
2. Using the time to complete a one way transmission in minutes students will determine the time it would take to complete two way transmission of the entire script.
3. This is done by multiplying the time for a one way transmission by the number of transmissions.
4. If that answer is over 60 minutes it should be divided by 60 to give the answer in hours and minutes. This will be true for the planets Jupiter through Pluto.
5. Students compute the day and time their transmission would be complete.

IX. Discussion
1. Between which two planets did you see a change from time in minutes to hours?
2. What is the first and second set of planets called? (inner and outer planets)
3. What lies between these two sets of planets? (the astroid belt)

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SPACE TALK

MESSAGE

You need to send the following important message to Space Bases on the moon and the planets and to receive their responses. Use the transmission time from "How Long Does It Take to Say Hello?" to determine how long each set of transmissions will take.

1. Earth to _____. Do you read me?
2. _____ to Earth. You're coming in loud and clear.
3. All Space Bases must tune in to Channel Z8 on Friday, 9:00 A.M. Solar Standard Time.
4. What's so important?
5. The President of the Galactic Federation will be speaking.
6. Roger, Earth, we'll be listening. This is _____, over and out.

Divide yourselves into small groups and time yourselves to see how much of this transmission can be sent and received in your school day. Use the "Space Talk" worksheet-"Time to Transmit"- to see how long each set would take to complete.

Write your own set of messages sent and received. Determine how long it would take to complete them.

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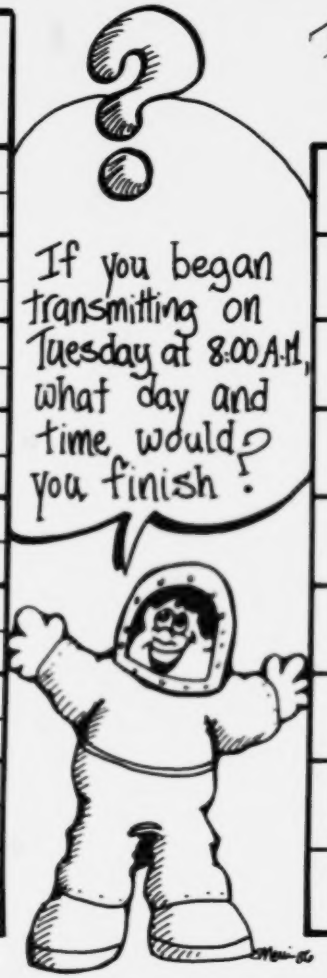
SPACE TALK

COMMUNICATIONS ENGINEER

TIME TO TRANSMIT.....

Use the data from "How Long Does It Take to say Hello?" to compute the total transmission time for your message.

	One Way Transmission Time from Earth	X	Number of Transmissions	=	Total Transmission Time	Time at Completed Transmission (Day)	(Time)
Moon					minute : seconds :		
Mercury					hours: minutes:		
Venus					hours: minutes:		
Mars					hours: minutes:		
Jupiter					hours: minutes:		
Saturn					hours: minutes:		
Uranus					hours: minutes:		
Neptune					hours: minutes:		
Pluto					hours: minutes:		



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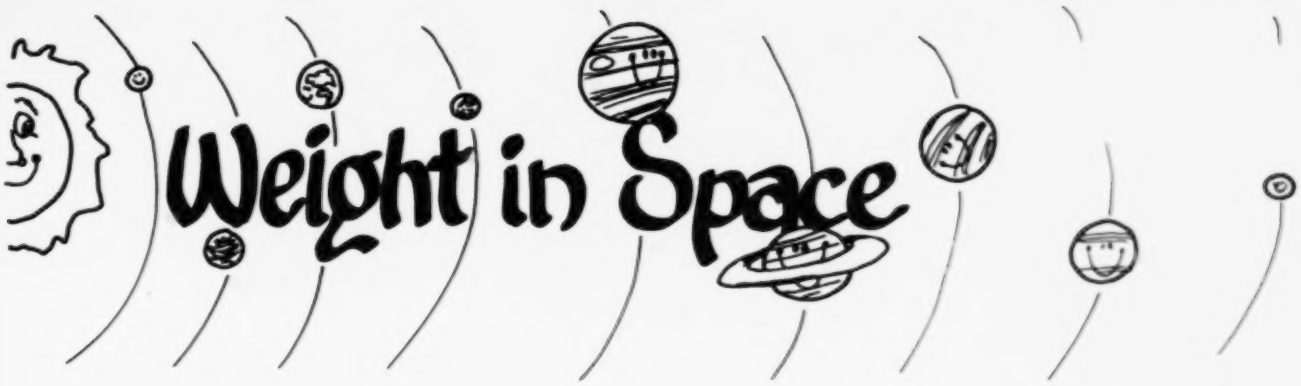

I. Topic Area
Planets

II. Introductory Statement
Students will determine their weight on the moon and the other planets.

III. Math Skills
a. Computation with decimals
b. Reading a table
c. Rounding
d. Graping
e. Estimating

Science Processes
a. Classifying
b. Comparing data
c. Interpreting data
d. Predicting and inferring
e. Applying and generalizing

IV. Materials
Student worksheets
Pencils
Calculators (optional)

V. Key Question
What do you think you would weigh on the moon or one of the planets?

VI. Background Information
The surface gravity of earth is considered as 1 and the moon and the other planets are considered as a fraction of that. Students multiply the decimal fraction times their weight in either pounds or kilograms to determine their weight on the various planets. Information about the planets varies. The figure of .05 for Pluto is a scientific estimate. Students should be reminded that events such as the Voyager II passage of Uranus are constantly updating our information about space.

The gravity of an object is related to its mass and density. The more mass an object has, the stronger its pull of gravity. Gravitational pull weakens with distance. The large outer planets are not dense and compact like the earth and so have a gravitational pull less than we would expect. Saturn actually has a density less than water and so would float.

VII. Management
a. This activity will take about 30-40 minutes
b. Students can either be weighed in class or bring their recorded weight from home.
c. If students are sensitive about their weight they could use a weight they would like to be.
d. Students round their weight to the nearest pound or kilogram and record this under actual weight on the first worksheet.
e. Students subtract to find how much more or less they would weigh on a planetary body than on Earth and record this in the difference column on the first page.
f. Students will graph their weights on the various planets using the third worksheet.

VIII. Discussion
a. What would be some of the effects of the different weights?
b. What causes the differences in surface gravity?
c. If Uranus is larger than the earth why is its surface gravity less?
d. What would it be like for you on the moon? (or Jupiter etc.)

IX. Extensions
a. Have students research the mass and density of the various planets. What effect does this have on the surface gravity?
b. If a computer is available students might use a program such as "Planetarium on Computer" by Focus Media Inc., which explores the concept of mass as well as orbit and location.
c. Worksheet 4 is a Basic program which students can use to determine their weight on the planets.

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Weight in Space

Name _____

Gravity is an invisible force that pulls on things. The pull of earth's gravity is what gives us weight. The size, mass, and density of a planet or moon determines its gravitational pull. We consider the surface gravity of the earth to be 1. Look at the chart of surface gravities of the moon and other planets and predict what you think your weight would be on each of them.

My weight on earth is _____ .

	Surface Gravity	Predicted Weight	Actual Weight	Difference
Moon	.16			
Mercury	.39			
Venus	.91			
Mars	.38			
Jupiter	2.60			
Saturn	1.07			
Uranus	.90			
Neptune	1.15			
Pluto	.05			

On which planet would you weigh the least? _____

On which planets would you weigh more than on the earth? _____

On which planets would you weigh nearly the same as on earth? _____

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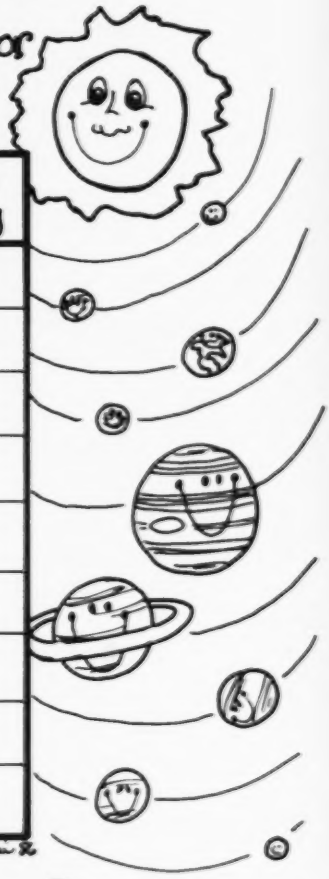
Name _____

Weight in Space-2

To find your actual weight on the moon and the planets, you must multiply your weight on earth by the surface gravity of that body. Find your weight on the moon first and then follow the formula to complete the chart below.

Use the surface gravities from the chart on the previous page. Round your answer to the nearest whole number.

The surface gravity on the moon is one sixth or .16 that of earth.



Planetary Body	My Weight on Earth	× Surface Gravity	= My weight on Planetary Body
Moon			
Mercury			
Venus			
Mars			
Jupiter			
Saturn			
Uranus			
Neptune			
Pluto			

For which planet was your prediction the closest? _____

For which planet was your prediction the most different? _____

On which planet was your weight closest to that on earth? _____

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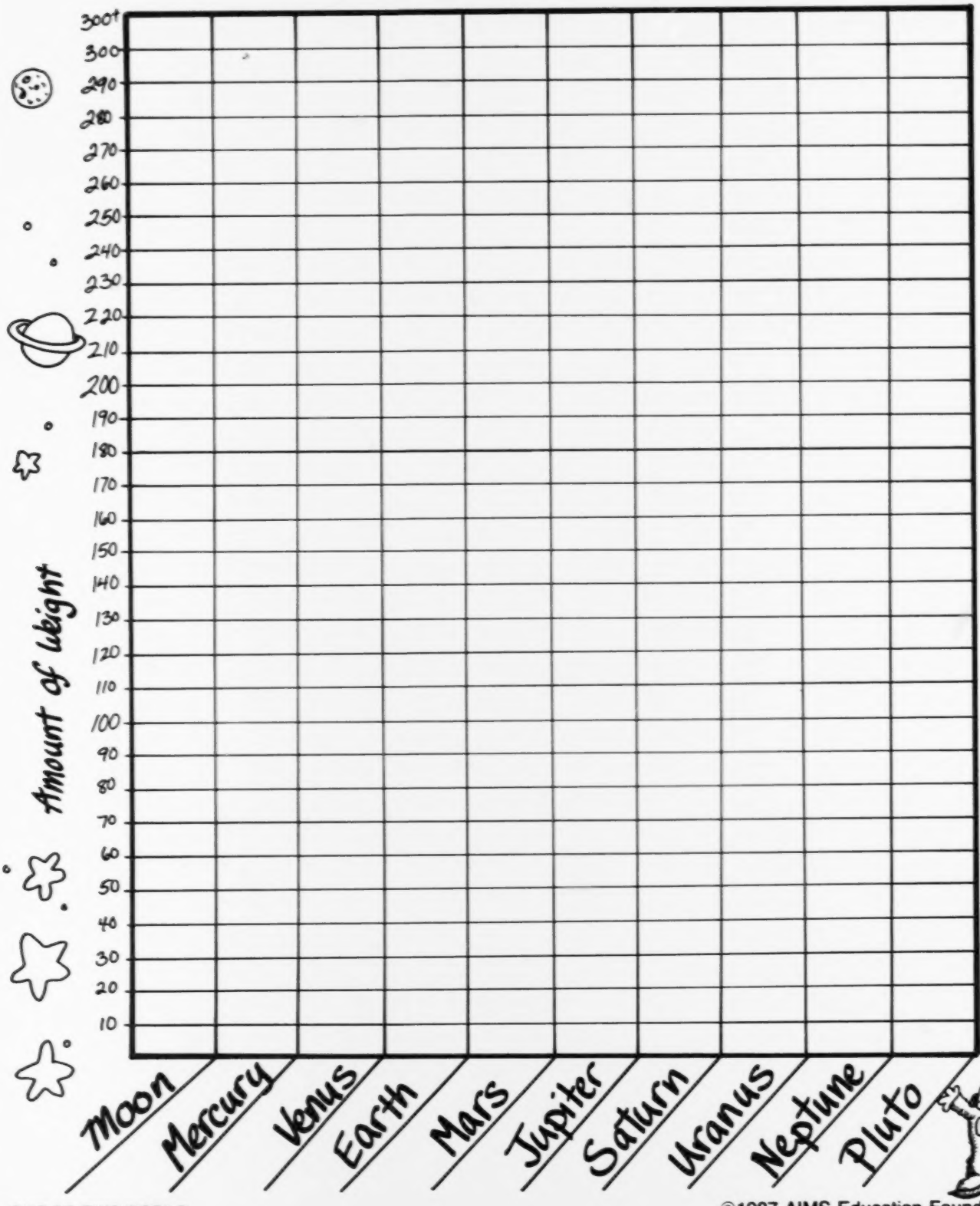
Weight in Space Graph

Voyager



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YOUR WEIGHT IN SPACE

```
10    REM : THIS PROGRAM CALCULATES YOUR WEIGHT ON OTHER PLANETS
20    PRINT " THIS PROGRAM WILL TELL YOU HOW MUCH YOU WILL WEIGH ON OTHER PLANETS
25    HOME
30    INPUT "WHAT IS YOUR WEIGHT ON EARTH?";A
40    INPUT "WHAT PLANET ARE YOU ON?";Z$
45    PRINT
50    IF Z$ = "MERCURY" GOTO 120
60    IF Z$ = "VENUS" GOTO 150
70    IF Z$ = "MARS" GOTO 180
80    IF Z$ = "JUPITER" GOTO 210
90    IF Z$ = "SATURN" GOTO 240
100   IF Z$ = "URANUS" GOTO 270
110   IF Z$ = "NEPTUNE" GOTO 300
115   IF Z$ = "PLUTO" GOTO 330
120   LET ME = A * .16
130   PRINT "ON MERCURY YOU WOULD WEIGH ";ME
135   PRINT
140   GOTO 40
150   LET V = A * .91
160   PRINT "ON VENUS YOU WOULD WEIGH ";V
165   PRINT
170   GOTO 40
180   LET MA = A * .38
190   PRINT "ON MARS YOU WOULD WEIGH ";MA
195   PRINT
200   GOTO 40
210   LET J = A * 2.6
220   PRINT "ON JUPITER YOU WOULD WEIGH ";J
225   PRINT
230   GOTO 40
240   LET S = A * 1.07
250   PRINT "ON SATURN YOU WOULD WEIGH ";S
255   PRINT
260   GOTO 40
270   LET V = U * .90
280   PRINT "ON URANUS YOU WOULD WEIGH ";U
285   PRINT
290   GOTO 40
300   LET N = A * 1.15
310   PRINT "ON NEPTUNE YOU WOULD WEIGH ";N
315   PRINT
320   GOTO 40
330   LET P = U * .05
340   PRINT "ON PLUTO YOU WOULD WEIGH ";P
345   PRINT
350   GOTO 40
```


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GALACTIC GAMES

I. Topic Area

Planets

II. Introductory Statement

Students will compute gravity factors to determine how far and high they could jump and throw on a planetary body.

III. Math Skills

a. Whole number computation
b. Averaging
c. Rounding
d. Measurement, length and time
e. Calculations
f. Problem solving

Science Processes

a. Observing
b. Measuring
c. Gathering and recording data
d. Interpreting data
e. Applying and generalizing

IV. Materials

Student worksheets
Pencils
Paper
Ink pad
Measuring tape
Stopwatch
Nerf or other light weight ball
Calculators (optional)

V. Key Question

How far or high can you jump and throw on the moon and the planets?

VI. Background Information

Gravity is an invisible force that pulls on objects. All the planets in our solar system have a gravitational pull. The gravitational pull of each planet is different because of its mass and density. The surface gravity of Earth is considered to be 1. Students will use the surface gravity of the moon ahd planets to compute gravity factors. By multiplying that factor by any measurable activity on Earth they can determine their performance on another planetary body. The gravity factor for three pairs of planets round to the same number.

VII. Management

a. Students work in small groups.
b. Students use worksheet 1 to compute the gravity factor for the moon and the planets.
c. Students complete three trials for each kind of jump and throw.
d. Students record their trials on worksheet 2 and find their averages.
e. Students multiply their averages by the gravity factors to determine their performance on the moon and the planets.
f. Students record on worksheet 3.

VIII. Procedure

Worksheet 1

a. Students first divide to find the gravity factor for the moon and planets.
b. Students record which three pairs of planets have gravity factors which are the same.

Worksheet 2

a. Mark off a starting place with masking tape.
b. With feet on starting line students jump as far as possible.
c. Measure distance from starting line to the nearest point their body touches. (heels, hands, whatever)
d. Record distance on worksheet and repeat two more times.

Gravity Defiance

a. Tape a piece of butcher paper to a wall or pole.
b. Have student mark his index finger using the ink pad.
c. Have the student reach as high as he can and mark the paper. This is the base mark.
d. Have the student jump and mark as far as he can. He should write his initials by his mark.
e. Measure the distance between the base mark and the jumped mark.
f. Enter the information on the worksheet and repeat for two more trials.

Planetary Pitch

a. Mark off a starting place with masking tape.
b. With feet on starting line students throw the ball as far as possible.
c. Measure distance from starting line.

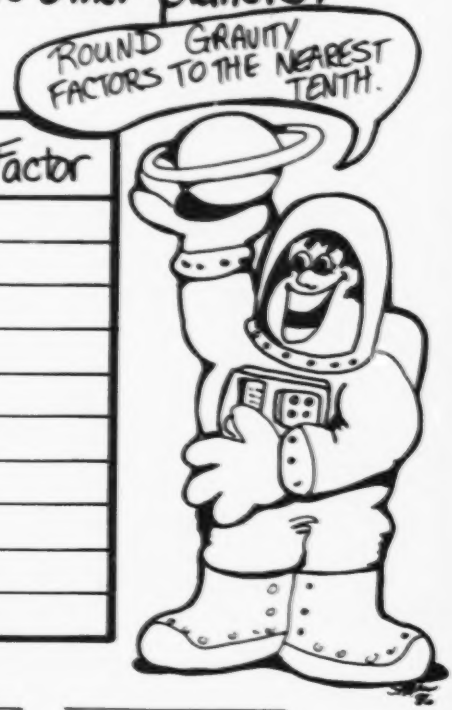
(continued on Page 44)

COMPETITOR

GALACTIC GAMES

Gravity is an invisible force that pulls on objects. Each of the planets in our solar system has a gravitational pull that is different because of its mass and density. The surface gravity of Earth is considered to be 1. Each planet has a different surface gravity. Athletic events on other planets would have much different outcomes. To find the gravity factor for each of the planets, divide the surface gravity of Earth (1) by the surface gravity of each planet. Find the gravity factor for each planet.

Use this gravity factor to determine how long and how high you can jump and throw on the other planets.



Planetary Body	Gravity on Earth		Surface Gravity		Gravity Factor
Moon	1	÷	.16	=	
Mercury	1	÷	.39	=	
Venus	1	÷	.91	=	
Mars	1	÷	.38	=	
Earth	1	÷	1	=	
Jupiter	1	÷	2.60	=	
Saturn	1	÷	1.07	=	
Uranus	1	÷	.90	=	
Neptune	1	÷	1.15	=	
Pluto	1	÷	.05	=	

On which pairs of planets is the gravity factor almost the same?

1. _____ _____
2. _____ _____
3. _____ _____

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GALACTIC GAMES

Name of Competitor: _____ Names of Team Members: _____

Name of Team: _____

Flag:

Compete in each event. Make 3 trials and find the Average.

1 Quantum Leap

Trial 1: _____

2: _____

3: _____

Total: _____

Average: _____

2 Gravity Defiance

Trial 1: _____

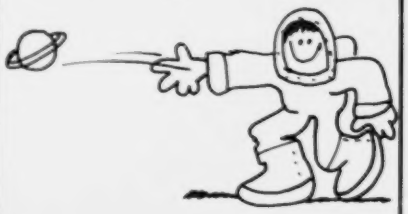
2: _____

3: _____

Total: _____

Average: _____

3 Planetary Pitch



Trial 1: _____

2: _____

3: _____

Total: _____

Average: _____

4 Asteroid Throw

Trial 1: _____

2: _____

3: _____

Total: _____

Average: _____

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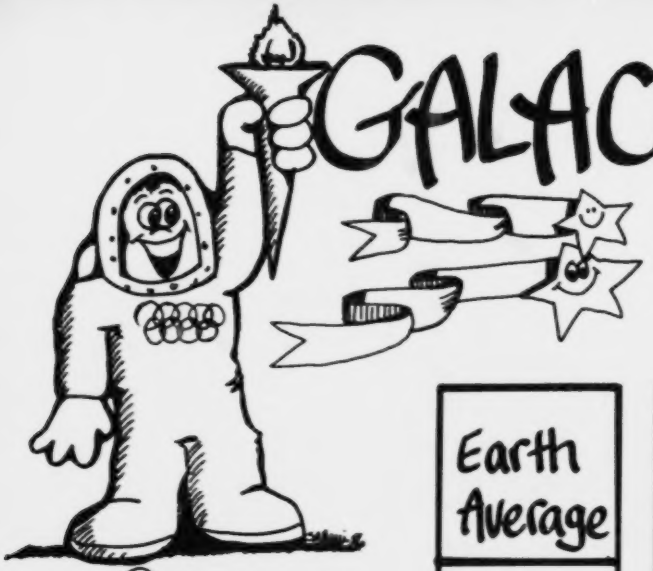
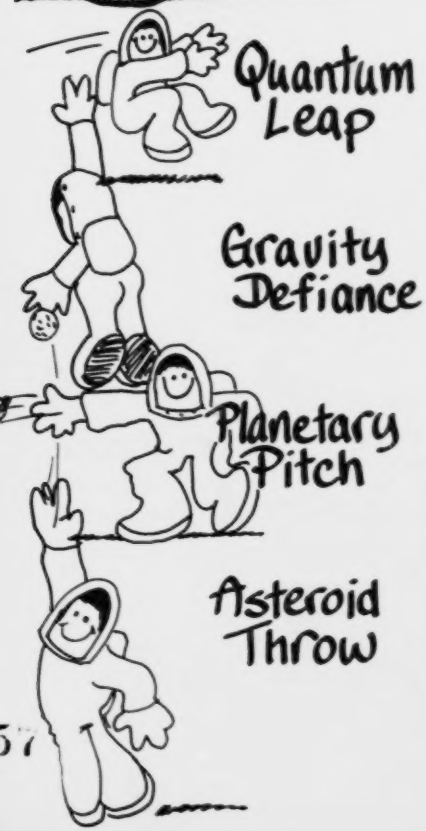


GALACTIC GAMES

Competitor's Name: _____

Team Name: _____

FORMULA: Average X Gravity Factor = Distance



Earth Average	Moon x 6.3	Mercury & Mars x 2.6	Venus & Uranus x 1.1	Jupiter x .4	Saturn & Neptune x .9	Pluto x 20

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GALACTIC GAMES

Galatic Games, continued...

d. Record distance on worksheet and repeat two more times.

Asteroid Throw

a. This activity should be done outdoors in a clear area.
b. Student throws the ball in the air at the timer's signal.
c. The timer times the ball from the time it leaves the student's hand until it hits the ground.
d. Record the information on the worksheet and repeat for two more trials.

IX. Discussion

a. On which planetary body would you score the highest and lowest?
b. What are some everyday tasks that would be difficult on the moon, on Jupiter? Why?
c. What are some other earthly events we could measure?
d. On which planetary bodies would your performance be closest to that on earth?

X. Extensions

a. Have students measure other activities and compute for the planets.
b. Graph the results, comparing the planets.
c. Have students try to perform every day tasks with weights on their legs or arms.
d. Have the students throw lighter or heavier objects and compare the time and height they reach.

XI. Curriculum Coordinates

a. Have students write what it would be like to live on the moon or one of the planets.
b. Have students write what it would be like to play a baseball game on the moon or one of the planets.
c. Read Matthew Looney's Invasion of Earth, the story of a young moon boy, by Jerome Beatty.

PLANET TRIVIA CARDS

I. Topic Area

Planets

II. Introductory Statement

Students play Planet Trivia as a means of reinforcing and reviewing material.

III. Science Processes

Problem solving

IV. Materials

One set of trivia cards and directions for each 2-9 students
One blank page per student to write additional questions

V. Key Question

Can you use the information you have learned to win Planet Trivia?

VI. Background Information

Most of the answers can be found in the material in this book. A few questions such as, "What star is closest to the earth?" (the sun), are general knowledge questions. Students should be encouraged to write questions of their own that can be added to the set.

VII. Management

a. Play time will vary depending on whether play is done individually or by teams and how many players there are.
b. Divide students into groups. Students can play as individuals into groups of 2-8 students or in teams of two to four players each.
c. Each group is given a set of cards and a rule sheet.
d. The player or team with the most cards at the end of the playing time wins.

VIII. Procedure

a. Each group plays for a given length of time following the rules for individual or team play on the rule sheet.
b. Students use a blank sheet to write additional questions for the game.

IX. Discussion

a. Which questions were the most difficult to answer?
b. Which questions were the easiest to answer?
c. What are some additonal questions we can add to the game?

X. Curriculum Coordinates

Students can develop a trivia game for other subjects.

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Planet Trivia
Game Rules

Two to eight players for each set of cards, individual or in teams of two to four players each.

INDIVIDUAL PLAY

Deal six cards face down to each player. This is your hand for the first round of Planet Trivia. Set any extra cards aside.

The person to the right of the dealer begins by asking the person on his or her right a question. If the correct answer is given, the player giving the answer takes the card, keeping it separate from his or her hand. If an incorrect answer is given, the person asking the question reads the correct answer and places the card in the discard pile at the center of the table. Play passes to the right until everyone has used their six cards. The player with the most cards at the end of the game is the winner. To play again, shuffle and redeal.

TEAM PLAY

Shuffle the cards and deal each team 16 cards face down. Set remaining cards aside. Teams take turns asking questions of the opposing team. Teams are allowed 20 seconds to confer before giving an answer, but only one answer may be given. When a team answers correctly it keeps the card. If an incorrect answer is given, the correct answer is read and the question is placed in the discard pile. Play continues until both teams use all sixteen cards. The team with the most cards wins.

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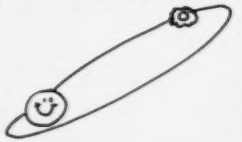
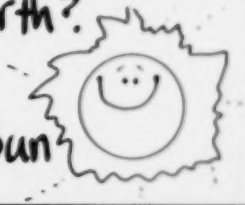
PLANET TRWIA CARDS

Q: What planet was discovered in the 20th century? A: Pluto ♇	Q: Which planet is considered to be Earth's twin in mass and size? A: Venus ♀	Q: Which planet has the longest day? A: Venus ♀	Q: Which planet is farthest from the sun?  A: Pluto
Q: Which planet is closest to the sun? A: Mercury	Q: What is the second largest planet in the solar system? A. Saturn	Q: What star is closest to Earth?  A: the Sun	Q: Which planet has the most moons? A: Saturn
Q: Which planet has the largest volcano in the solar system? A: Mars	Q: What is the astronomical term for the distance light travels in a year? A: a light year	Q: Which planet travels around the sun once every 248 Earth years? A: Pluto	Q: Which two planets have no moons? A: Venus & Mercury
Q: What mythological person was the planet closest to the earth named for? A: Venus - goddess of love	Q: What fraction of your weight would you weigh on the moon? A: one sixth ($\frac{1}{6}$)	Q: What is the largest planet in the solar system? A: Jupiter	Q: Which planet has the shortest year? A: Mercury

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OUT OF THIS WORLD

PLANET TRIVIA CARDS

Q: Which planet has a surface gravity closest to that on Earth?

A: Saturn

Q: Which planet boasts the Great Red Spot?

A: Jupiter

Q: What space probe photographed the rings of Uranus?

A: Voyager II.

Q: What is the largest satellite orbiting the Earth?

A: the Moon

Q: Which planet has the largest mass?

A: Jupiter

Q: Which planets did the Mariner spacecraft explore?

A: Venus & Mars

Q: What planet is often referred to as the morning and evening star?

A: Venus

Q: What are the solar system's planets named for?

A: Ancient Gods

Q: On which planet would you weigh the least?

A: Pluto

Q: Which planet's day is closest in length to Earth's?

A: Uranus

Q: Which planet is called the Red Planet?

A: Mars

Q: What planet was discovered beyond the orbit of Saturn in 1781?

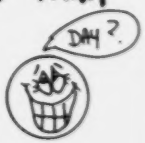
A: Uranus

Q: Which planet has a density less than water?

A: Saturn

Q: Which planet has a day longer than its year?

A: Venus



Q: Which planet is brightest as seen from Earth?

A: Venus

Q: What is the Earth's home Galaxy called?

A: The Milky Way

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OUT OF THIS WORLD

PLANET TRIVIA CARDS

Q: What planet is named for the god of the sea and what is its symbol?
A: Neptune, trident

Q: What is an astronomical unit equal to?
A: Earth's distance from the sun

Q: Which planet has seasons, other than earth?
A: Mars

Q: Which planets are larger than Earth?
A: Jupiter, Saturn, Uranus, Neptune

Q: Which planet spins on its side?
A: Uranus

Q: What is the name of the unit astronomers use to measure near by space distances?
A: Astronomical unit

Q: How many months does it take for the moon to revolve around the earth?
A: one

Q: Which planets are smaller than Earth?
A: Mercury, Mars, Pluto, Venus

Q: Which planet has "ears"?
A: Saturn

Q: Which two planets sometimes switch places in their orbits?
A: Neptune, Pluto

Q: Which planet has a moon almost as big as itself?
A: Pluto

Q: What are the names of the outer planets?
A: Jupiter, Saturn, Uranus, Neptune, Pluto

Q: Which planet is surrounded by acid clouds?
A: Venus

Q: Which planet is sometimes called a double planet?
A: Pluto

Q: How fast can we radio messages through space?
A: the speed of light

Q: What are the names of the inner planets?
A: Mercury, Venus, Earth, Mars

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PLANET TRIVIA CARDS

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PHONE HOME

I. Topic Area

Space voice communication and recognition of geometric shapes.

II. Introductory Statement

The students will experience how space voice communication worked early in the space program, will familiarize themselves with geometric shapes, learn to give clear instructions, and practice careful listening to one of their peers.

III.

Math Skills	Science Processes
Recognizing geometric shapes	Communicating
Recognizing relative positions	Observing
Computing percentages	Measuring and comparing
Division	Applying and generalizing
Constructing geometric shapes	

IV. Materials

Geometric shapes (either cut out of pattern or constructed shapes).
Small ziplock baggies or paper envelopes
Student worksheets
Two 8½"x11"sheets of paper or sheets of construction paper for each team
Scissors, crayons, and compass (optional)
Overhead projector (optional)
Colored plastic shapes for overhead (optional)

V. Key Question

If you were an astronaut in a space ship, how could you repair malfunctioning functioning equipment with instructions coming from mission control?

VI. Background Information

Early in the space program, it was necessary to rely entirely on voice communication to give and receive instructions. This is still true in some settings. A special skill is involved in being able to give precise and clear instructions, to listen with care, and to follow such instructions accurately.

VII. Management Suggestions

1. This experiment may take 2 or 3 days to complete, depending upon whether or not students learn to construct the shape. The teacher has the option of letting the student draw their shapes or having them cut the ones already provided.
2. With younger children, it might be easier to have the shapes already made and placed in the baggies. If you have the shapes made in advance, start with day 2 of the procedure.
3. Each student team must have two identical sets of shapes, one for the astronaut and the other for the mission control officer. Eight different shapes are included for this lesson. Congruent shapes should be colored the same. The emphasis is on shape recognition rather than differentiating color. If the atribute of color is also to be used, than each set of shape must be produced in several colors.

VIII. Procedure

Day 1

1. If you are making your own shapes, have the students follow the directions for construction provided. Make sure that the partners in a team draw the same size shapes and color them the same.
2. Have the student teams cut out the shapes and place them in baggies or envelopes. Each baggie should have two of each size, shape, and color.

Day 2

3. Have the pair of students decide which one of the two will be the mission control officer and who will be the astronaut.
4. Pass out the baggies. Have each team divide the shapes so that each has a set of congruent shapes. Provide each team with two instrument panels (8½"x11" sheets or sheets of construction paper).
5. After the students have their shapes ready, take the students through the following practice run of directions or a similar series. The teacher or a student who has been briefed can be the mission control officer for this exercise. All other students play the role of astronauts. When giving these instructions during this practice session it might be helpful to display the shapes on the overhead projector so that the students can look at yours to see if they have placed theirs correctly. In these instructions it is assumed all students have figured with the same color configuration.

Astronaut Jane:
Place your retangular instrument panel in front of you so the longer side of the rectangle is at the bottom. Place the large square in the upper left hand corner of the instrument panel.

Astronaut Jane:
Place the small circle in the middle of the square.

Astronaut Jane:
Place the large rectangle along the right side of the square so its longer side touches the top of the instrument panel.

Astronaut Jane:
Place the large circle so it is tangent to the large rectangle at the mid-point of its base.

Astronaut Jane:
Place the small hexagon in the center of the circle.

Astronaut Jane:
Place the large hexagon in the lower right hand corner of the instrument panel so one side rests on the bottom of the rectangle.

Astronaut Jane:
Place the small ellipse in the center of this large hexagon.

Astronaut Jane:
Place the small rectangle along the top side of the hexagon so it touches the right side of the instrument panel.

6. After you have finished giving directions, have the students answer the top part of their worksheet.
7. Now have the students sit back to back with their shapes in front of them. The student who is mission control will be giving directions to the student who is the astronaut. The first time the astronaut may not ask questions of mission control. When repeating the procedure, the students may ask questions of each other. It may be helpful to have the students say their name when giving directions to the other student.
8. Give the students a time limit of between 5 to 10 minutes. At the end of the time limit, have the students stand up and see how many shapes were correctly places.
9. Have students fill out their worksheets as they go. After everyone is finished answer the question on the student worksheet.

IX. Discussion

You may explain to the students that when the space program first began the astronauts did not carry television camaras on the ships. Mission control and the astronauts communicated without seeing each other, just by voices, so it was very important that the information given were correct and in detail.

1. Is it important to have good communication between mission control and the astronauts?
2. How do we benefit in our everyday life from the improvement in communicatin that have been made because of the space program?

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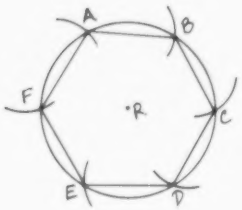
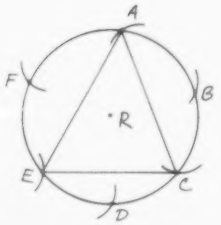
DIRECTIONS FOR MAKING GEOMETRIC SHAPES

HEXAGON



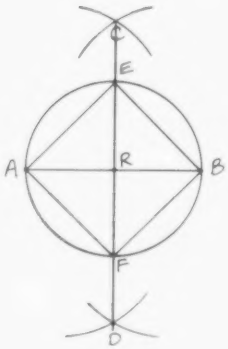
H1 Draw a circle on your paper.
H2 Label the center R.
H3 Choose a point on the circle and label it A.
H4 Use your compass and measure from A to R. Using the distance mark off arcs around the circle starting with point A.
H5 The last arc should intersect point A.
H6 Label each point where the arc and circle intersect B, C, D, E and F.
H7 Connect all points and you will have a Hexagon.

TRIANGLE



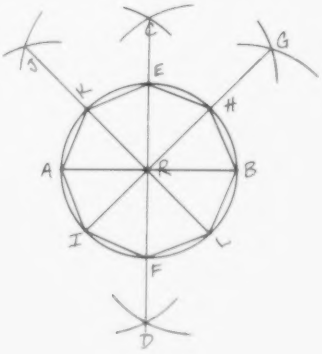
T1 Follow directions for hexagon H1 through H6.
T2 Connect points A, C and E and you will have a Triangle.

SQUARE



S1 Draw a circle and label the center R.
S2 Draw a horizontal line through the middle of the circle to the other side.
S3 Label the points that intersect the circle A and B.
S4 Using the distance from A to B, place your compass metal point on A and the pencil on B. Now swing your compass so that it makes an arc above and below your circle.
S5 Without changing the compass setting put your metal point on B and the pencil on A. Again make an arc above and below the circle. Label the intersections of the arcs C and D.
S6 Draw a line that goes through point C and D. At the two points where the line intersects the circle, label the first one E and the second one F.
S7 Connect points A, E, B, F. You will have a Square.

OCTAGON



O1 Follow steps S1 through S6 on the square directions.
O2 Place the point of your compass on point B and the pencil on point E and draw an arc.
O3 Keep your compass the same, and put your point on E and the pencil on B. Again, draw an arc. Label this point G where the two lines intersect.
O4 Draw a line that goes through point G and R to the other side of the circle.
O5 At the two points where the line intersects the circle, label the first point H and the second point I.
O6 Repeat steps O2 to O5 of the octagon directions. This time use points A and E. Then draw your two arcs above the circle. Label that point J.
O7 Label the points where the line intersects the circle K and L.
O8 Connect points A, K, E, H, B, L, F and I.

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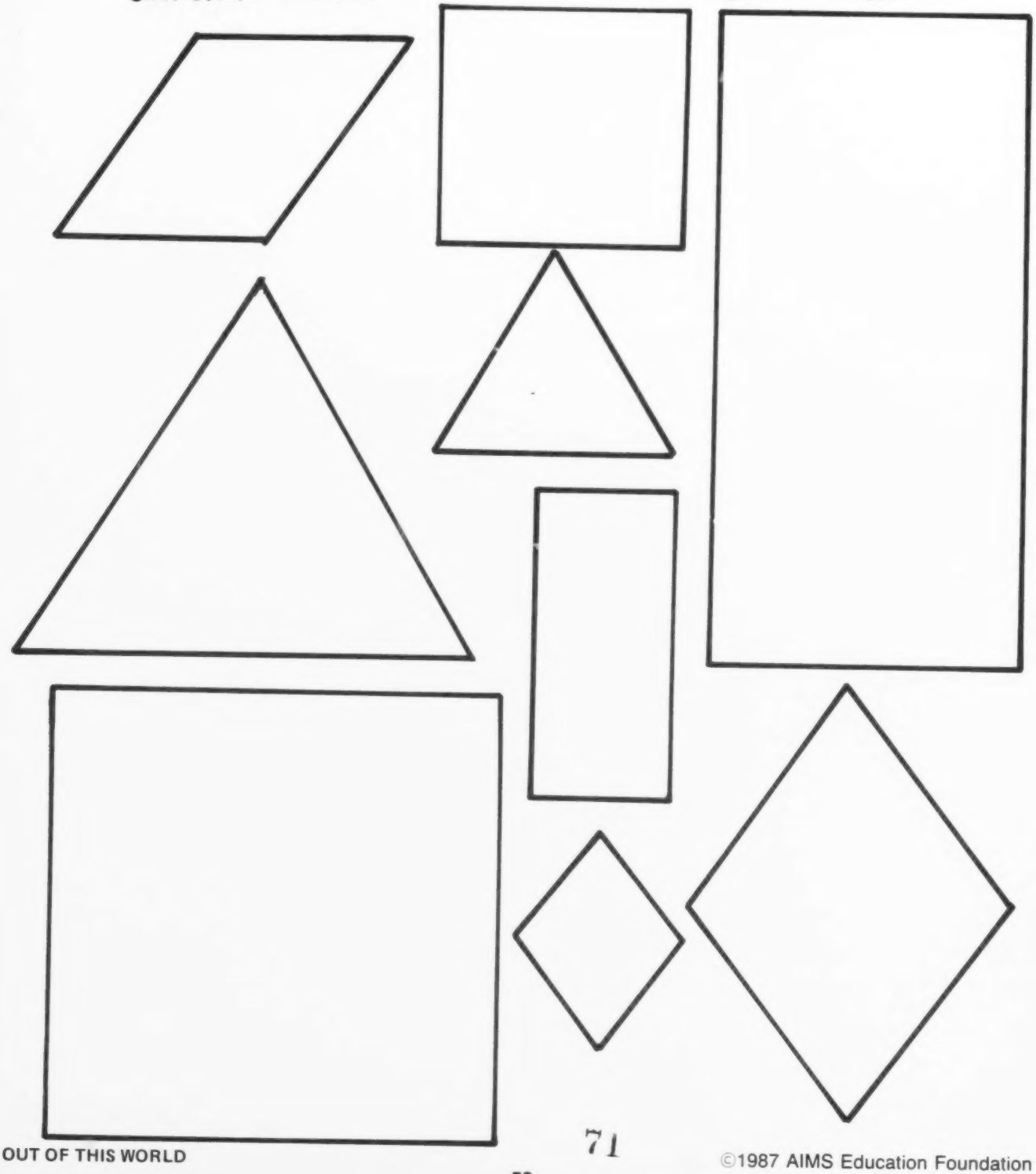
GEOMETRIC SHAPES



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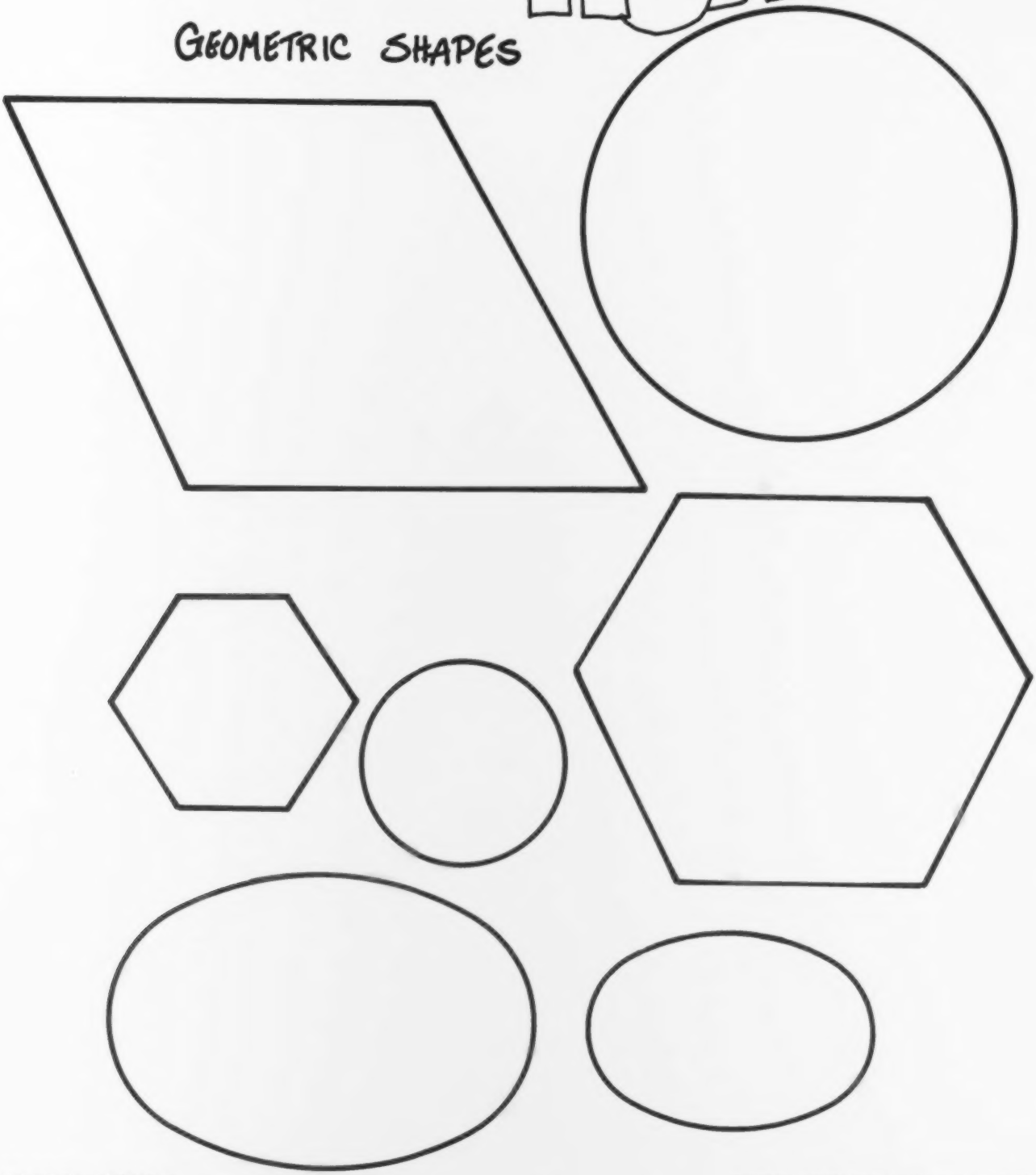
GEOMETRIC SHAPES



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Astronaut : _____
Mission Control: _____

1. You are an astronaut receiving instructions. Listen to the directions carefully. Try to place your shapes correctly without asking any questions.

My Results

# of Shapes Right	÷	Total # of Shapes	=	Percentage of Accuracy
	÷		=	

2. Next, work with a partner. Take turns being the astronaut and Mission Control. Listen to your partner's instructions and try to place your shapes correctly without asking questions. Record each person's results as the astronaut.

WITHOUT QUESTIONS

My Results

# of Shapes Correct	÷	Total # of Shapes	=	Percentage of Accuracy
	÷		=	

PARTNER'S Results

# of Shapes Correct	÷	Total # of Shapes	=	Percentage of Accuracy
	÷		=	

3. Try it one more time. This time, you may ask questions when given directions. Record each astronaut's results.

WITH QUESTIONS

My Results

# of Shapes Correct	÷	Total # of Shapes	=	Percentage of Accuracy
	÷		=	

Partner's Results

# of Shapes Correct	÷	Total # of Shapes	=	Percentage of Accuracy
	÷		=	

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Astronaut: _____

Questions

1. Who had the highest percentage of accuracy? _____

2. How many figures did you place correctly?
   Trial 2: _____ Trial 3: _____

3. On a scale of 1 to 10, how hard was it to be Mission Control?

   1 — 5 — 10

4. On a scale of 1 to 10, how hard was it to be the astronaut?

   1 — 5 — 10

5. Which of the two was harder for you? _____
   Why? _____

6. On a scale of 1 to 10, how hard was Trial 2? (no communication)

   1 — 5 — 10

7. On a scale of 1 to 10, how hard was Trial 3? (with communication)

   1 — 5 — 10

8. Which did you like better, being Mission Control or being the astronaut? Why? _____

9. What would you do to make communication better between the astronaut and Mission Control? _____

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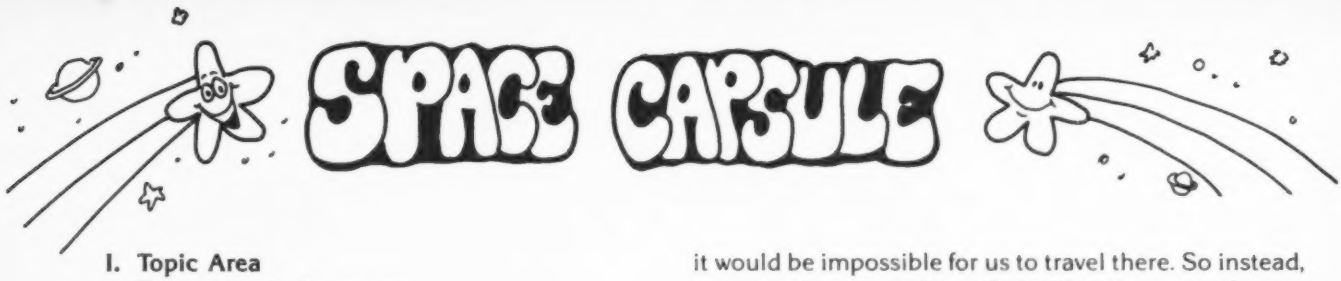

I. Topic Area
Time capsule for space

II. Introductory Statement
Students will determine what items they would send in a time capsule to extra-terrestrial life on another planet.

III. Math Skills
a. Conducting a survey
b. Sorting
c. Problem Solving
d. Graphing

Science Processes
a. Collection and recording data
b. Interpreting data
c. Generalizing

IV. Materials
Space Capsule Activity page
scissors
16 envelopes

V. Key Question
What would you send to another planet that might best exemplify how we live on the planet Earth?

VI. Management Suggestions
1. This activity may take 1-2 days to complete.
2. Reproduce two copies of the activity page for each student.
3. Label each of 16 envelopes with one of the listed categories for use in class.
4. If the choices within a category are too difficult or if this is a first time activity, it may be simplified somewhat by suggesting that all events or items emerge from only the twentieth century.

VII. Procedure
1. A suggested introduction may read as follows:

Let us assume that information has been gathered to indicate that extra-terrestrial life exists on other planets. Also let us assume that Life, with the ability to think, has been found; and now we wish to communicate with them. Because the distance between planets is so great, it would be impossible for us to travel there. So instead, we are going to send a rocket with a time capsule containing 16 well chosen items that will interpret and exemplify life on planet Earth. What should the capsel contain?

2. Each student responds individually by recording his or her choice in each of the 16 categories. Student files that page away for reference later.

3. Students meet in groups of three to four to discuss and come to agreement on responses and record on a second activity page. Record the number of students in each group in the small square at the bottom right corner of each category heading. Students cut second activity page apart and sort all responses by category into appropriately marked envelopes.

4. Students will then sort responses within each category to determine the top three responses in each category and the number of students selecting that item. Graph the total number of responses on the graph provided for each category.

5. Students will then predict how their responses would compare with students in similar age groups in different geographical areas.

6. Students will gather data to substantiate their predictions by corresponding with classrooms from other parts of the United States

IX. Discussion
1. What factors or variables influence one's choices within a category?
2. Discuss how one places value or worth on a given choice.
3. What methods were used to prioritize responses to any one question or category?

X. Extensions
1. Compare results in a survey conducted by students of their parents or grandparents. Where are the similarities and the differences?

2. See Space Capsule 2 where information is shared from a similar survey of Soviet youths. Compare.

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SPACE CAPSULE

What would you send to intelligent life on a planet outside <u>our</u> Solar System?

Think about what you would send to represent human life on earth. Write down your responses. Cut apart the strips, place the strips into groups. Tabulate and display your results by graphing.

FAMOUS PERSON:	IMPORTANT INVENTION:
PAST EVENT:	APPLIANCE:
MOVIE:	ELECTRONIC EQUIPMENT:
TELEVISION PROGRAM:	SAMPLE TRANSPORTATION:
BOOK:	SAMPLE SPORT EQUIPMENT:
COMIC STRIP:	GAME:
MUSIC:	TOY:
FOOD:	YOUR CHOICE:

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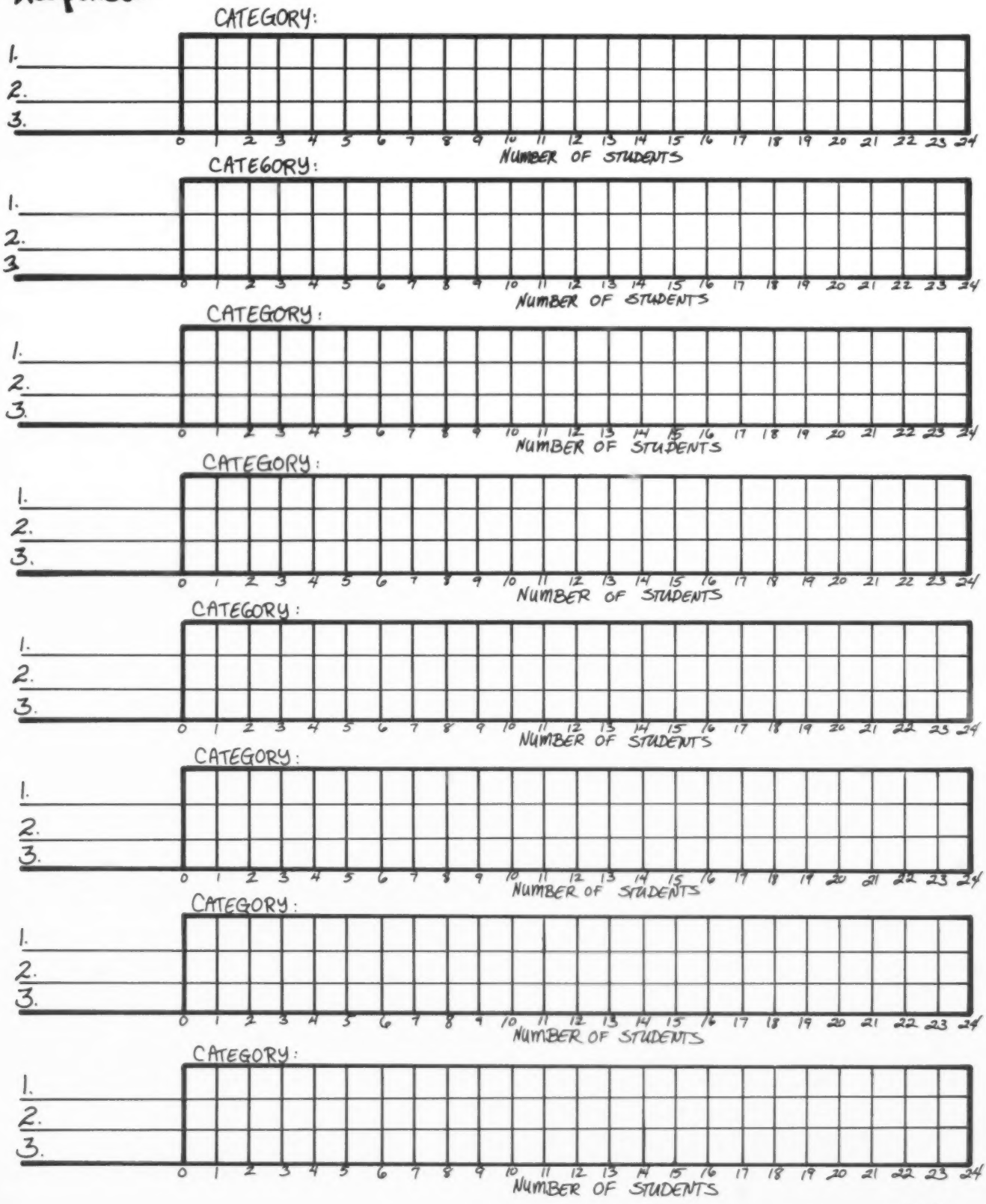
TOP 3 Responses SPACE CAPSULE - SURVEY RESULTS



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Around the Planets in How Many Days?

I. Topic Area

Astronomy-Diameter of the planets

II. Introductory Statement

The students will compare travel time around the equator of each of the planets.

III. Math Skills

a. Division
b. Multiplication
c. Graphing
d. Rounding off
e. Formulas
f. Averaging

Science Processes

a. Collecting and recording data
b. Interpreting data

IV. Materials

Student worksheet
Pencil
Calculators (optional)

V. Key Question

How much money will you have to spend in fuel to make a trip around the equator of each planet?

VI. Background Information

Planet	Circumference	Diameter	Hours
Mercury	15,323km	4,880km	158
Venus	38,007	12,104	392
Earth	40,053	12,756	413
Mars	21,311	6,787	220
Jupiter	448,392	142,800	4623
Saturn	378,684	120,600	3904
Uranus	159,512	50,800	1644
Neptune	152,604	48,600	1573
Pluto	9,420	3,000	97
Total			**13,024**

Planet	Days	Liters of Fuel	Cost
Mercury	7	1022	$ 408.80
Venus	16	2534	1,013.60
Earth	17	2670	1,068.00
Mars	9	1421	568.40
Jupiter	193	29,892	11,956.80
Saturn	163	25,246	10,098.40
Uranus	69	10,634	4,253.60
Neptune	66	10,174	4,069.60
Pluto	4	628	251.20
Total	544	84,221	$33,688.40

A Land Rover gets 15 kilometers per liter of fuel at a cost of $.40 per liter, and travels at a speed of 97 kilometers per hour.

VII. Management Suggestions

a. This experiment may take 45 to 90 minutes to complete depending on the arrangement of groups.
b. This experiment may be done individually, in small groups, or as a whole class with different students taking one planet to work out the information.
c. You may want to use calculators.

VIII. Procedure

a. Explain to the students that they will be traveling around the equator of each planet in a Land Rover. The surface texture of each planet will not be taken into consideration. The Land Rover will travel at a speed of 97 kilometers per hour and fuel will cost $.40 per liter.
b. Have the students estimate the number of days it will take to go around the equator. Also have the students estimate the amount of fuel they will need for their journey.
c. Have the students estimate the number of days it will take to go around the equator of the planets.
d. Have the students compute the cost of fuel for the trip.
e. Explain to the students how to use the different formulas to answer the questions on the student worksheet. The students will need to round every number to the nearest whole number except the final cost.

IX. Discussion

a. How close was your estimate to what it really costs?
b. How close was your estimate to how many days it will take?

X. Extended Activities

a. Have the students draw a picture of their Land Rover, and explain why it is built the way they have it drawn.
b. Have the students keep a log of their journey and the adventures that happened.

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Around the Planets in How Many Days?

Imagine that it would be possible to travel in a land rover around the equator of each planet in our solar system. Your land rover can travel at a speed of 97 km per hour, gets 15 km per liter of fuel, and the fuel costs $.40 per liter. First estimate the number of days and the cost of the fuel it would take for each planet, then compute to find the actual time and cost.

	Estimation of Days	Estimation of Cost $	Circumference at Equator	# Hours (C ÷ 97 Kmph)	# Days (Hours ÷ 24)	Fuel Needs (C ÷ 15 = # Liters)	Fuel Costs (# Liters X $.40)
Earth			40,053				
Mercury			15,323				
Venus			38,007				
Mars			21,3111				
Jupiter			448,392				
Saturn			378,684				
Uranus			159,512				
Neptune			152,604				
Pluto			9,420				
				Total		Total	

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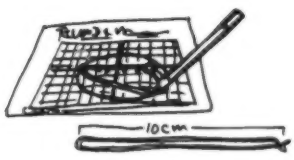
Round and Round



I. Topic Area

The elliptical orbits of planets

II. Introductory Statement

Students will construct the shape of planets' orbits in our solar system by drawing ellipses. They will study the effect of several variables on the resulting shape.

III. Math Skills

a. Measurement
b. Constructing ellipses
c. Examining limits

Science Processes

a. Observing
b. Comparing
c. Interpreting data
d. Generalizing

IV. Materials

Pushpins
String
Pencils
Cardboard sheets (8.5"x11")
Student worksheets
Metric rulers

V. Key Question

What is the shape of a planet's orbit?

VI. Background Information

The closer the planet is to the Sun, the more circular the orbit. The farther the planet is from the Sun, the more elliptical the shape of the orbit.

An ellipse has two foci, represented by pushpins in this investigation. If the foci are separated by a distance equal to one-half the length of the closed loop, then the ellipse will be at one limit: a straight line. Note that the loop would then be drawn tight. If the pushpins would have no thickness the loop would just be a double line. The other limit is reached when the two foci are at one position. In that case, the result would be a circle.

In the first investigation, the length of string forming the loop will be 20 centimeters long and remain as the constant. The variable will be the distance between the foci ranging from where both are at the same position at A (only one pin should be inserted); to where they are separated by 10cm at F_1 and F_2, in which case a straight line results.

In the second investigation the length of string will be the variable and the distance between foci the constant. The shorter the string, the flatter the ellipse and the longer the string the more nearly circular will be the ellipse.

VII. Management

It is best to do this activity in centers with 3 - 4 students in each group. They can alternate drawing the ellipses.

VIII. Procedure

a. Supply each group with the two student worksheets, two pushpins, cardboard backing, string and metric ruler.
b. Have students tie the string very carefully to produce the size loops specified.
c. Demonstrate how to make the construction as shown below. The pencil must be held tightly against the string to draw the line.
d. Have students complete both investigations.

IX. Discussion

a. If the length of the loop is held constant, what happens as the distance between the foci increases? When does it become a line? a circle?
b. If the distance between the foci is held constant, what happens as the length of the loop increases?

X. Extension

Have the students use different colored construction paper to make the different ellipses described below or others decided upon by the class. Then have them mount the smallest on the next larger, etc. to create a colorful display. Here is an example of patterns:

Centers	Tacks-Distance	String Length
#1	9cm	25cm
#2	8cm	25cm
#3	12cm	30cm
#4	15cm	35cm
#5	13cm	35cm
#6	11cm	40cm
#7	14cm	40cm
#8	10cm	45cm
#9	12cm	50cm

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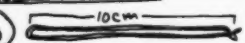
Round and Round

Name _____

Tie a string so that its total length is 20cm (10cm doubled up) 

. Place this paper on a piece of cardboard. Push in 2 pins (foci), one at F and F'. Place your string around the 2 pins and draw your first ellipse. Then, successively, place your pins at EE', DD', CC', BB', and A (foci are together).

F E D C B A B' C' D' E' F'

Conclusion: _____

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Round and Round

Name _____

In this investigation, the variable will be the length of string. Place the pins at E and E'. Draw each ellipse using these foci. Change the length of string each time. Start with 16cm (straight line) and then test 18cm, 20cm, 22cm, and 24cm lengths.

F E D C B A B' C' D' E' F'

Conclusion: _____

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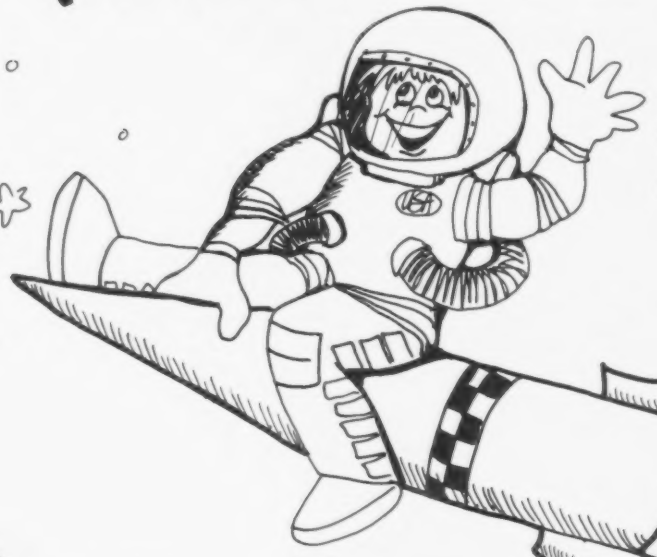
SPACE SURVIVAL AWARD

has been presented to

Astronaut: _____



for outstanding decisions in the face of extreme danger.

Medal of Honor

Dated: _____

Signed: _____

Galactic President

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The Shines Bright

I. Topic Area

The apparent movement of the moon

II. Introductory Statement

Students will chart the apparent movement of the moon over a five-hour period and use the information to predict when the moon will rise the following evening.

III. Math Skills

a. Measuring angles
b. Recording data in a table
c. Graphing
d. Computing an average
e. Applying information

Science Processes

a. Observing
b. Measuring
c. Organizing data
d. Comparing
e. Inferring
f. Applying

IV. Materials

A Clear night at approximately full moon
Student worksheets

V. Key Question

Can we predict when the moon will rise tomorrow evening?

VI. Background Information

Each night the moon will appear a little further to the east amongst the stars as the moon pursues its path around the earth. It is this latter movement which causes it to rise approximately fifty minutes later each night. By measuring the progress of the moon over a five hour period, students should be able to arrive at this approximation and from that predict the rising time of the moon with accuracy. The movement per half-hour is easily detected since the movement per hour is about 14-15 .

VII. Management Suggestions

This investigation requires nothing except the student worksheets and the construction of the "lunometer" shown on one of them. The investigation is most interesting if done around full moon. Full moon finds the moon rising at the same time the sun is setting...that is, they are in opposite directions as viewed from the earth.

VIII. Procedure

1. Divide the class into observaton groups. Since this is an evening activity, groups will have to live in the same neighborhood. If some students do not have partners, suggest that their parents help them as the readings are made.
2. Provide each group or individual with all of the student worksheets.
3. Have each student prepare a "lunometer".
4. Give students practice in using their lunometers by finding the angle of the tops of buildings, trees, etc.
5. Discuss the record sheet for recording the readings.
6. Instruct the students to watch for the moon to rise and carefully record the time. If there are mountains or other obstructions to the east they will also have to measure the beginning elevation of the moon as it rises. Observing the moonrise time the day before and adding 50 minutes to that time will predict the time it will rise on the evening of the experiment. Students can then be alerted to be ready at a relatively precise time.
7. Have students take readings every thirty minutes for a five-hour period. Special dispensation may be required from parents. Another alternative is to use a four-hour period.
8. Students will then compute the average movement in degrees per half-hour and hour. From this they will compute how long it will take to move through 360 degrees.
9. Students will graph the results in half-hour increments. Since the graph will approximate a straight line, students should observe that a uniform result is occurring. Therefore, the line can be extended until it reaches the 90 degree mark. At that point, one-fourth of the moon's rotation has been completed. By reading the time for that point, students can determine how long it takes for the moon to make one-fourth of its journey around the earth. Multiplied by four will give the approximate time for the next evening's moonrise.
10. Students will predict the moon's rising time for the four nights following the initial evening of observation, check it with the actual time, compute the differences, and find the per cent of error.

IX. Discussion

1. How accurately can we predict moonrise?
2. Which individual or group made the most accurate prediction? Why?
3. Could we predict when the moon will rise ten days from now? How?
4. What causes the moon to rise and to set?

Note: Title of this activity is taken from the song "My Old Kentucky Home". If there is objection to using the title in this form the letters **ly** can be added to the word **Bright** before duplication.

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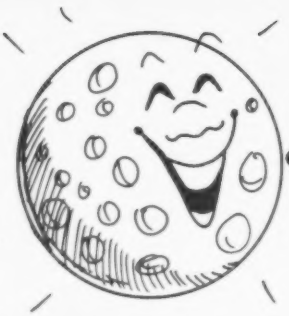
The Shines Bright



Name _____

In the investigation, you will chart the movement of the moon for 5 hours beginning at moonrise. The best time of month is just before full moon. At full moon, the moon rises at the time the sun sets.

Carefully record the time the moon rises and make a measurement of its angle of elevation with your luneometer. This will be zero unless the moon rises behind hills or mountains. Repeat the measurement in every 30 minutes. Observe the timing with care. Enter the information into the table.

One person needs to point the lunometer at the moon and the other take the reading on the scale.

	Time	Angle of Elevation	Amount of Change in 30 minutes
moonrise:			
Total of Change:			
Average Change:			

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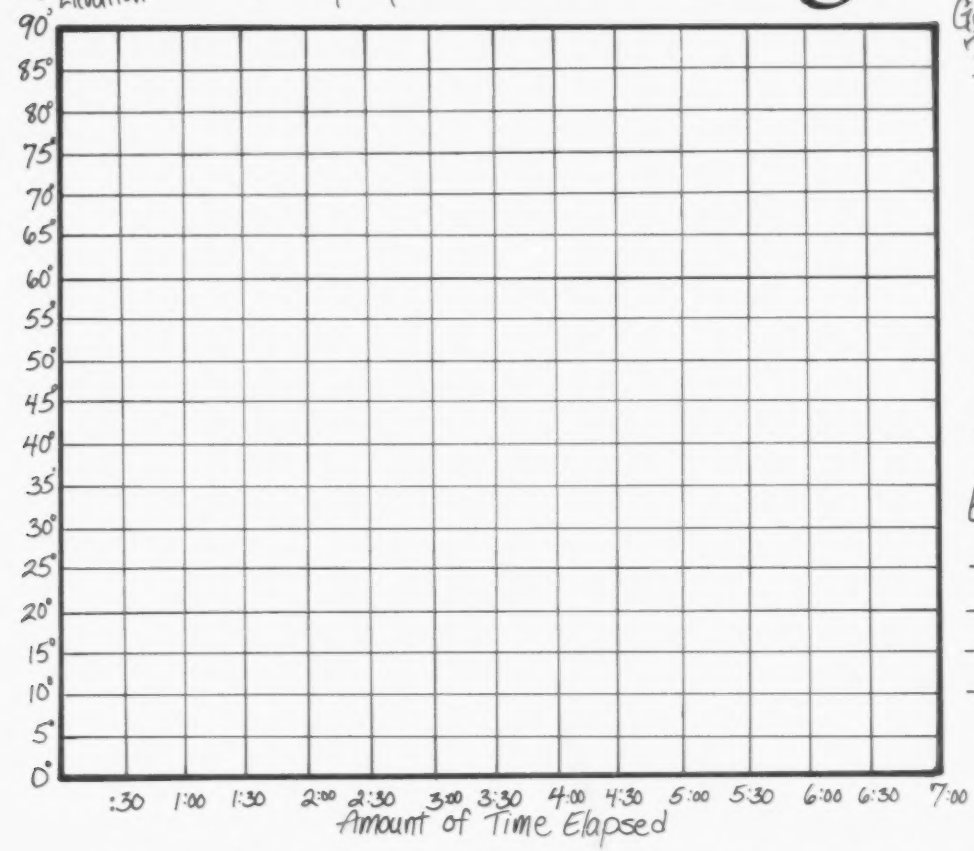
Name _____

The Shines Bright

Graph the Results



How long (in hours and minutes) will it take to have a change of 360 degrees?

_____

Explain: _____

_____

_____

_____

_____

Using the information from your observation predict when the moon will rise in each of the 4 evenings following. Observe the actual rising time and compute your percent of error. Use the time of moonrise observed above for the first date.

Evening:	Date of Observation	Predicted Moonrise Time	Actual Moonrise Time	Difference in Minutes	Per Cent of Error
Initial (full moon)					
First					
Second					
Third					
Fourth					
			Totals:		
			Averages:		

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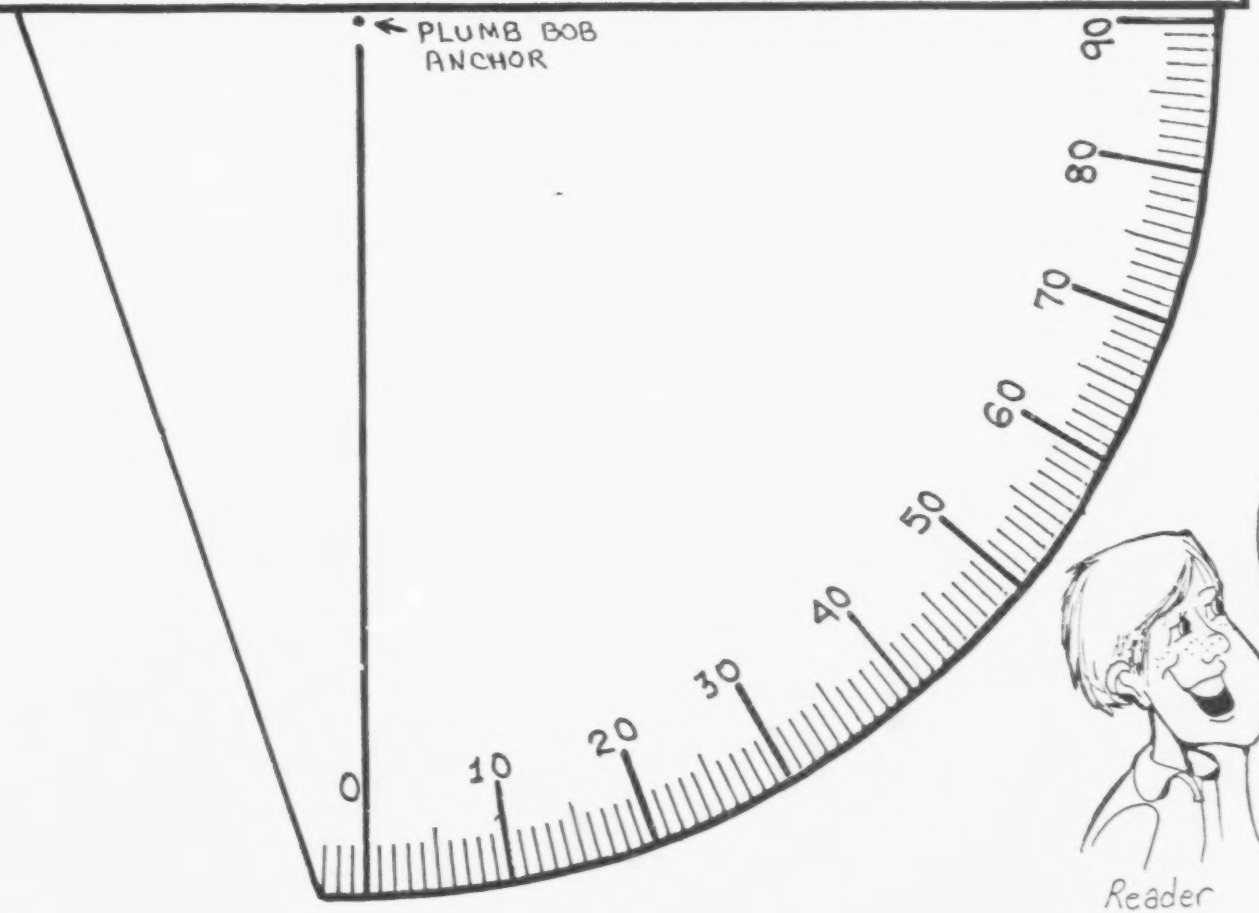
LUNEOMETER



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ADDITIONAL RESOURCES

Young Astronaut Council
1211 Connecticut Avenue, N.W., Suite 80
Washington, D.C. 20036
(202) 682-1985

Astronomical Society of the Pacific
1290 24th Avenue
San Francisco, CA 94122

Hansen Planetarium
15 South State Street
Salt Lake City, UT 84111

Educational Programs Officer
NASA Ames Research Center
Moffett Field, CA 94035
(415) 965-5543/4

MIRA (Monterey Institute for Research in Astronomy)
P. O. Box 1551
Monterey, CA 93940
(408) 375-3220

RELATED SOFTWARE

Mickey's Space Adventure
Personal Computer Software
(Available free as part of the Technology in the curriculum materials.)

Elementary Vol. 4 Math/Science
Ecology, Astronomy, Arithmetic
MECC

Space Mission Problem Solving
Orange Cherry Software

Your Universe
Focus Media

Planetarium On Computer: The Solar System
Focus Media

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